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# Field Studies of Aphid Vectors of Sugarcane Mosaic and Methods of Control.

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# FIELD STUDIES OF APHID VECTORS OF SUGARCANE MOSAIC AND METHODS OF CONTROL

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# TABLE OF CONTENTS

Page

LIST OF TABLES

| TABLE | | Page |
|---|---|---|

TABLE Page

## LIST OF FIGURES

| FIGURE | | Page |
|---|---|---|

## ABSTRACT

Field studies were conducted in Louisiana during 1962 and 1963 to determine in sugarcane fields the seasonal abundance of flying aphid populations and of the major component species, to relate the occurrence of aphids to the spread of sugarcane mosaic, to determine how effective insecticides might be in maintaining disease-free seed cane for planting, and to determine if milk, which has acted as a virus-inhibitor in mechanically inoculated plants, would have any effect on disease spread under field conditions where transmission is by aphids.

Winged aphids were caught on sticky traps and also collected while on sugarcane plants. Mosaic incidence was determined periodically by sampling randomly selected stalks in some plots, and by counting all stalks and those showing symptoms in other plots. Systemic insecticides were applied to large 5- and 10-acre plots of sugarcane. Small plots were treated with milk and casein sprays.

Of the 7 known vectors of sugarcane mosaic, only _Acyrthosiphon pisum_ (Harris), _Schizaphis graminum_ (Rondani), _Rhopalosiphum maidis_ (Fitch) and _Hysteroneura setariae_ (Thomas) occurred during periods of virus spread in sufficient numbers to be considered of probable importance in the spread of mosaic disease. These 4 species plus _Aphis medicaginis_ Koch, _Rhopalosiphum pseudobrassicae_ (Davis), _Rhopalosiphum splendens_ (Theobald), _Aphis gossypii_ Glover, _Aphis maidiradicis_ Forbes,

*Myzus persicae* (Sulzer), *Therioaphis maculata* (Buckton) and *Rhopalosiphum fitchii* (Sanderson) constituted 90% of the total aphids representing 69 species which were caught on sticky traps during these studies. Aphids were trapped in greatest abundance during March and April. Flying aphid populations were much lower during fall than in spring, but higher than in summer.

Flying populations of all species mentioned above, except *T. maculata*, were found to be highly and significantly correlated by simple correlation methods with periodic increases in mosaic. There was also a high correlation between disease spread and the total numbers of flying aphids. There were only slight indications from multiple correlation analysis that *M. persicae*, *H. setariae*, *A. pisum* and *S. graminum* might be more important in the spread of mosaic than the other species.

Except for *R. pseudobrassicae*, winged forms of all aphids mentioned above, plus *Sipha flava* (Forbes), *Dactynotus ambrosiae* (Thomas), *Chaitophorus viminalis* Monel, and *Aphis* sp., were caught on plants. Only *H. setariae* and *R. maidis* were found colonizing sugarcane.

Data on mosaic incidence indicate that: (1) Approximately 80% of the total mosaic spread during one crop year occurred during late winter and spring. (2) Temporary loss of mosaic symptoms during a hot dry summer apparently was not associated with loss of virus from plants. (3) There was no significant difference in the rate of spread of mosaic among sugarcane plants of different ages. (4) The rate of spread of mosaic was greater in sugarcane adjacent to diseased cane than in sugarcane more distant from diseased cane.

Ten and 24 applications of 1/4 pound of demeton per acre per application significantly reduced populations of flying aphids and gave reductions of mosaic incidence amounting to 58% and 45% when 11% and 26% of the stalks in untreated plots showed mosaic symptoms, respectively. The 58% reduction was achieved in spite of poor timing of insecticide application. The 45% reduction was achieved when the test plot was adjacent to heavily infected sugarcane. These results suggest that systemic insecticides, together with roguing of diseased plants and isolation from virus sources, might provide a better method for maintaining disease-free seed cane than is currently available.

Milk and casein sprays applied weekly reduced mosaic spread in small field plots, but were phytotoxic. Skim milk was less phytotoxic than undiluted or diluted whole milk, and casein was least phytotoxic of all.

# INTRODUCTION

For the past several years immediately preceding this study sugarcane mosaic, almost forgotten for 2 decades by Louisiana growers, again has become a major disease problem. This is generally attributed to the growing of recently released varieties of sugarcane which are susceptible to mosaic, and to the appearance of a new strain of the mosaic virus.

Previous entomological studies of sugarcane mosaic have dealt mainly with the ability of different insect species to transmit the virus in cages or greenhouse tests. Several unsuccessful attempts have been made to obtain control of virus spread by insecticide applications in small field plots in which nearby colonizing aphids were controlled, although it is now generally believed that the spread of stylet-borne viruses depends primarily on flying aphid populations.

Removal of diseased plants, isolation of seed plots and resistant varieties for many years have been considered to be the only practical approaches to mosaic control. However, the seriousness of the problem is thought to be increasing in spite of all efforts to reduce it.

The studies reported in this dissertation were undertaken with the following objectives in mind: (1) to determine the seasonal abundance of flying aphid populations of different species; (2) to relate the abundance of aphid species to the spread of mosaic disease;

(3) to determine how effective insecticides might be in maintaining disease-free seed cane for planting; and (4) to determine whether milk, which inhibits the virus in mechanically inoculated plants, would have any effect on aphid transmission in the field.

## REVIEW OF THE LITERATURE

The greatest consideration in sugarcane mosaic transmission studies previously has been given to determining aphid species capable of transmitting the disease. Table I lists those aphid species which have been reported as vectors and shows their efficiency as vectors in cage experiments. Few efforts have been made to identify aphid populations flying over sugarcane fields or found on sugarcane plants. Several unsuccessful attempts have been made to control sugarcane mosaic by controlling its vectors.

### Vectors of Sugarcane Mosaic

Brandes (1920) was the first to show that the corn leaf aphid, *Rhopalosiphum maidis* (Fitch) could transmit sugarcane mosaic. This was the first vector reported for this virus and according to Smith and Brierly (1956) was reported at a time when very little was known about virus transmission by aphids. Ingram and Summers (1936, 1938) found the rusty plum aphid, *Hysteroneura setariae* (Thomas), and the greenbug, *Schizaphis graminum* (Rondani), to be capable of transmitting sugarcane mosaic. These findings were confirmed by other authors (Table I). In Puerto Rico, Tate and Vandenberg (1939) found that the sedge aphid, *Carolinaia cyperi* Ainslie, could transmit the mosaic virus. The same authors found that *Aphis nerii* Fonscolombe transmitted mosaic

Table I. Efficiency of different aphid species as vectors of sugarcane mosaic and time required for the symptoms to appear in cage experiments.

| Aphid Species | Exposed to Viruliferous Aphids | Infected with Mosaic Virus No. | Infected with Mosaic Virus % | Days Required for Symptoms to Appear Range | Days Required for Symptoms to Appear Average | Authority |
|---|---|---|---|---|---|---|
| Acyrthosiphon pisum (pea aphid) | 208 | 33 | 15.9 | - | - | Abbott and Charpentier (1963) |
| Amphorophora sonchi (green sowthistle aphid) | 70 | 14 | 20.0 | | | Abbott and Charpentier (1963) |
| Carolinaia cyperi (sedge aphid) | 192 | 60 | 31.3 | 20-42 | 27.6 | Tate and Vandenberg (1939) |
| | | | | 7-28 | 18.2[a] | |
| Dactynotus ambrosiae (red sowthistle aphid) | 270 | 253 | 93.7 | - | - | Abbott and Charpentier (1963) |
| Hysteroneura setariae | 419 | 24 | 5.7 | 15-45 | 27.8 | Ingram and Summers (1936) |
| (rusty plum aphid) | 137 | 11 | 8.0 | - | - | Tate and Vandenberg (1939) |
| Rhopalosiphum maidis | 19 | 17 | 89.5 | 19-47 | 23.7 | Brandes (1920) |
| (corn leaf aphid) | 16 | 5 | 31.2 | 12-28 | 20.8 | Kunkel (1922) |
| | 72 | 17 | 23.6 | 15-35 | 20.3 | Ingram and Summers (1936) |
| | 124 | 40 | 32.3 | 12-54 | 19.6 | Ingram and Summers (1938) |
| | 200 | 69 | 34.5 | - | - | Tate and Vandenberg (1939) |
| Schizaphis graminum | 28 | 2 | 23.6 | - | - | Ingram and Summers (1936) |
| (greenbug) | 172 | 21 | 12.2 | 10-45 | 19.1 | Ingram and Summers (1936) |
| | 67 | 15 | 22.4 | 20-28 | 21-28 | Seth and Chona (1961) |

[a]Cane from seedlings (other experiments from cuttings).

to one plant out of 4 tested; however, this find has not been tested since. The number of known vectors was recently increased by the work of Abbott and Charpentier (1963) who added the pea aphid, Acyrthosiphon pisum (Harris), the "red sowthistle aphid," Dactynotus ambrosiae (Thomas), and the "green sowthistle aphid," Amphorophora sonchi Oestlund, to this list.

Charpentier (1961) and Abbott and Charpentier (1963) do not doubt that there may be other vectors of sugarcane mosaic. They mentioned that there are 2 areas in Louisiana where incidence of mosaic is high, and others where the disease is not a problem, yet the same known vectors are present in these areas and exist under apparently identical conditions.

Lawas and Fernandez (1949) were able to transmit sugarcane mosaic (maize mosaic) from corn to corn, using the cotton aphid, Aphis gossypii Glover, as a vector. Vasudeva (1954) stated that the green peach aphid, Myzus persicae (Sulzer), transmitted the same virus to 2 corn plants.

Experimental attempts to transmit sugarcane mosaic with several other insects generally have failed. Kennedy et al. (1962) listed the yellow sugarcane aphid, Sipha flava (Forbes), as a vector of sugarcane mosaic. However, Loftin and Christenson (1932), Ingram and Summers (1936), Tate and Vandenberg (1939), and Abbott and Charpentier (1963) failed to get transmission with this aphid. Other insects which have been tested as possible vectors with negative results included Aphis (*rumicis*) *fabae* Scopoli, *Dactynotus* (*Macrosiphum*) *rudbeckiae* (Fitch), *Longiunguis* (*Aphis*) *sacchari* (Zehnt.), *Perkinsiella saccharicida* Kirk, *Draeculocephala mollipes* Say, *Sogata furcifera* (Horv.), *Pseudococcus boninsis* Kuw, and *Haplothrips graminis* Hood (Tate and Vandenberg, 1939; Kunkel, 1922; Brandes, 1920; and Ingram and Summers, 1936).

While it has not been clearly indicated in all transmission studies whether winged or wingless aphids were used, it is probable that wingless aphids were most often employed. Since most of the transmission in the field is believed to be by winged forms, it is worth mentioning that Sylvester (1955) and Toba (1963) found winged forms of *Myzus persicae* less efficient than apterous forms in transmitting lettuce and watermelon mosaic virus. Stevenson (1959) found that apterous and winged aphids of the same species were almost equally capable of transmitting potato virus Y. Simons (1959) and Rochow (1960) stated that there are considerable differences within aphid species in their ability to transmit viruses. Comparisons of the relative efficiency as vectors of different aphid species as shown in Table I probably are not entirely valid.

Brandes (1927) and Charpentier (1961) found the corn leaf aphid, *Rhopalosiphum maidis*, colonizing sugarcane plants. The latter worker observed it on N.Co. 310, which is considered to be a highly susceptible variety to mosaic. Kunkel (1924) stated that this aphid can readily live on sugarcane, but has never been observed to establish a colony. Leece (1938) and Chona (1944) were unable to find colonies of this aphid on sugarcane. Wolcott (1928) and Wildermut and Walker (1932) believed that the corn leaf aphid does not normally feed on sugarcane, but when obliged to move to cane when weeds are ploughed under, it becomes restless and transmits the disease. Loftin and Christenson (1932) found that the longevity of this aphid differs on different sugarcane varieties. They found that this aphid on one variety seldom lived more than a day, while those on 2 other varieties settled down and reproduced.

According to Ingram _et al_. (1939), the corn leaf aphid has been found in Louisiana on approximately 2 in every 1,000 plants inspected during winter and early spring, but it was seldom found on sugarcane later in the season when other preferred hosts are available. Normally, it is found on sugarcane in the central whorl.

Ingram _et al_. (1951) stated that among grasses, the corn leaf aphid prefers maiden cane (_Panicum hemitomon_ Schult), jungle rice (_Echinochloa colonum_ (L.) Link) and crabgrass (_Digitaria sanguinalis_ (L.) Scop.). They believed that the greatest transmission is accomplished when the aphids move from infected sugarcane plants to susceptible grasses and then back to sugarcane.

Van Breemen found in Java that there were seasonal migrations of _Rhopalosiphum maidis_ which could account for most mosaic spread (Brandes, 1927). However, Ingram _et al_. (1939), working in Louisiana with sticky traps placed above sugarcane plants, reported that _Rhopalosiphum maidis_ was only rarely collected, and that there was no evidence of a mass flight of any aphid species. They also found in other air traps that Rhopalosiphum maidis, Schizaphis graminum and Hysteroneura setariae, the 3 known vectors at that time, did not occur in great abundance at any time.

Wildermuth and Walter (1932) reported the development in one year of 39 to 50 generations of Rhopalosiphum maidis in cages at Brownsville, Texas, and 35 to 41 at Tempe, Arizona. At Tempe the alates were much more numerous during April and early May and again during September and early October than at other times of the year. They believed, as did Cartier (1957) and Orlob and Medler (1961), that this species may migrate long distances from south to north much as does the greenbug, Schizaphis graminum.

Ingram and Summers (1936) believed that the rusty plum aphid, Hysteroneura setariae, is the most abundant of all aphids found in sugarcane in Louisiana. According to them it usually lives in grasses throughout the year, including the perennial Andropogon sp., which is found along sugarcane field borders and on ditchbanks. Some of these grasses are hosts of sugarcane mosaic. Ingram et al. (1939) in population studies found almost 1% of the sugarcane plants infested with Hysteroneura setariae. Ingram et al. (1951) found the rusty plum aphid about 14 times as abundant as the corn leaf aphid on sugarcane, and about 25 times as abundant as the greenbug. This relative abundance of the rusty plum aphid caused Charpentier (1956) to believe that it was probably the most important vector in the field, though it does not appear to be as efficient as the other vectors. Summers *et al.* (1948) explained this apparent lower efficiency by the fact that the rusty plum aphid feeds more on the collar lobes than on the more succulent tissues in the plant whorl.

Ingram *et al.* (1939) found the greenbug, *Schizaphis graminum*, on sugarcane in greatest abundance during the spring and early summer. Crabgrass, a host of sugarcane mosaic, also is one of the favorite hosts of this aphid, and transfer of mosaic from this grass to sugarcane probably is of much importance. Both wingless and winged forms are usually found in the whorls of sugarcane plants (Ingram *et al.*, 1938). This vector is not as uniformly distributed in Louisiana sugarcane fields as the rusty plum aphid or the corn leaf aphid (Ingram *et al.*, 1950). Orlob and Medler (1951) reported long distance dispersal by winds of alates of the greenbug from areas south of Wisconsin.

Ingram *et al.* (1939) reported that *Carolinaia cyperi* had not been found on sugarcane in Louisiana. However, he stated that it had been found a few times on *Cyperus* spp. growing in sugarcane fields, and undoubtedly moved to sugarcane plants from this adjacent host.

According to Abbott and Charpentier (1963), enormous populations of the pea aphid, *Acyrthosiphon pisum*, develop on white sweetclover (*Melilotus alba* Dest.) which is planted as a winter legume on some Louisiana sugarcane plantations. Swarms of winged forms are sometimes observed above the sweetclover fields, and many are carried by air currents to fields nearby. They observed many *Acyrthosiphon pisum* on cane after sweetclover was ploughed under in late winter. This was followed by high incidence of mosaic. However, they also stated that sweetclover is grown in areas having both high and low incidence of mosaic.

Ditman *et al*. (1943) observed pea aphid migrants as early as April 24, in Maryland. They also found that there was a tendency for this aphid to migrate from crops such as red and crimson clover to the more preferred hosts which are alfalfa, pea, and vetch.

Abbott and Charpentier (1963) found that *Dactynotus ambrosiae* and *Amphorophora sonchi*, which infest sowthistle (*Sonchus asper* (L.) All), a common weed in some sugarcane fields, developed in large populations on this host. From this host they apparently moved to sugarcane plants where they were frequently observed. Heavy migrations of these species have been noted following spring applications of herbicides for weed control. The same authors reported that these species are prevalent only during late winter and early spring, and apparently are chance inhabitants of sugarcane.

Ingram *et al*. (1939) reported a mass flight of *Rhopalosiphum pseudobrassicae* (Davis) and *Hyalopterus pruni* (Geoffr.) over sugarcane fields, both of which were also found on the plants.

Dickson *et al*. (1949) found in Southern California that *Myzus persicae*, *Brevicoryne brassicae* Linnaeus, *Rhopalosiphum pseudobrassicae*, *Schizaphis graminum* and *Aphis gossypii* comprised 95% of the trapped aphid population, 80% of which was *Myzus persicae*.

Aphids were most abundant during March and April. Dickson *et al.* (1956) found *Aphis gossypii* and *Aphis medicaginis* Koch occurring on sticky traps throughout the year with greatest abundance during the spring. Another smaller increase was observed in late fall. Close and Lamb (1961) in New Zealand also reported that more aphids were trapped during spring than during summer months.

## Miscellaneous Studies of Sugarcane Mosaic

Abbott (1963) stated that by 1961, the mosaic susceptible varieties N.Co. 310, C.P. 52-68 and C.P. 44-101 comprised 88% of the sugarcane acreage in Louisiana. He also mentioned that roguing, which had not been practiced for 20 years, was again recommended, and that a committee on mosaic control had arranged with selected growers for the production of seed cane in fields where roguing was practiced. Four or 5 roguings were recommended. The cost was about $2 per acre for each roguing. Abbott (1959) also stated that fields from which seed cane is to be taken should be examined in the spring and rogued where the infestation does not exceed 2%. He also reported (1960) that a new virus strain, which he called strain H, was found in 16 out of 17 fields of C.P. 52-68, and in 25 out of 34 fields of N.Co. 310. He also reported that the average yield reductions were 16.2% in the variety N.Co. 310 and 33.2% in the variety C.P. 52-68.

Forbes and Steib (1960) reported that by roguing every 2 weeks they could keep mosaic incidence below 2% in areas with adjacent fields almost 100% diseased. Forbes _et al_. (1961) recommended that mosaic free seed cane be reproduced by roguing out diseased plants and by having seed plots well isolated from mosaic infected fields.

Martin _et al_. (1961) stated that in Louisiana mosaic spreads more rapidly in spring months than during summer, and that considerable spread may also occur during fall in young cane planted in late summer. The same authors stated that it has not been determined whether this higher spread during spring and fall is due to the greater susceptibility to infection of the young plant tissues or to seasonal differences in vector activity.

Zummo (1963) presented data which indicate that there was some fall spreading of mosaic; however, he did not indicate in his studies the relative importance of fall spread compared to spread during other seasons of the year.

According to Edgerton (1959), sugarcane mosaic in the United States has been reported on _Zea mays_ L., _Sorghum vulgare_ Pers., _Pennisetum glaucum_ (L.) R. Br., _Miscanthus sinensis_ Anderss, _Paspalum boscianum_ Flügge, _Digitaria sanguinalis_ (L.) Scop., _Setaria lutescens_ (Weigel) Hubb., _Setaria magna_ Griseb., _Echinochloa crusgalli_ (L.) Beauv., _Panicum dichotomiflorum_ Michx. and _Brachiaria platyphylla_ (Griseb.) Nash. He also stated that most of the grasses which are susceptible to mosaic and which are found near cane fields are annuals, and that the disease dies out with them at the end of the season. Anzalone (1963) reported on the susceptibility of rice to a strain of the sugarcane mosaic virus.

Martyn (1946) found that in some varieties mosaic symptoms may be so faintly apparent as to escape casual observation, but that symptoms generally become more pronounced in such varieties during wet weather.

Brandes (1920b) observed numerous cases of "recovery" from mosaic in sugarcane as well as in other grass hosts of the virus. Ocfemia et al. (1933) found that in recovered plants, absence of mottling in the leaves was not due to absence of virus, but to masking of symptoms. Also, according to Tims et al. (1935) the virus may still be present in plants which apparently have recovered from mosaic. However, Forbes and Mills (1943) were not able to make successful inoculations with juice from plants from which symptoms had disappeared. East (1931), in experiments involving precipitin reactions of sugarcane proteins, found some slight indications that a recovered plant undergoes a reduction of the virus rather than eliminating it entirely.

Summers et al. (1948) observed that there was a very close positive relationship between the numbers of newly infected sugarcane plants and their proximity to other diseased plants. However, Laird and Dickson (1963) did not find such a relationship in pepper plants with tobacco etch virus or potato virus Y, which also are non-persistent or stylet-borne viruses.

## Aphid Transmission of Other Stylet-Borne Viruses

Mass migration of aphids occurs and, according to Johnson (1954), is probably due to the coincidence of high populations with the kind of weather which permits local concentration, rather than to behavioral phenomena. He also states that there are usually 3 main population surges during the season--once in spring, once in summer, and again in autumn, each usually lastin ı several weeks. He believed that high humidity depressed multiplication rather than inhibited flight. However, Broadbent (1949) stated that the combination of high humidity and high temperature sometimes inhibits flight.

Haine (1955) found that, once in the air, aphids lost control over their flight direction and were blown away by wind speeds as low as 1.2-1.5 m.p.h. Johnson (1956) found that wind determines the direction of travel and that this is reflected by the intensity of infestation of the windward eges of fields. Elton (1925) found that aphids had been transported by the wind from a distance of over 800 miles.

Kennedy (1950) points out that aphids exercised selection between suitable and unsuitable hosts mainly after alighting on them. He believed that if a crop was suitable for some species of aphids which were not often inclined to fly away, then these aphids probably would not be the most effective virus vectors in this crop. The same author (1958) found that alightment and take-off of *Aphis fabae* Scopoli on unsuitable hosts may be repeated many times and that the dissatisfied aphid will not settle down to feed even when it is finally exhausted.

Kennedy _et al_. (1959) found that there was some host selection by the flying _Myzus persicae_, but concluded that, whatever the stimulus may have been, the pre-alightment response was far from being specific. They believed that spread of a stylet-borne virus is favored by polyphagus aphid species, and by aphids which alight on partially acceptable or borderline hosts more than by aphids which alight on favorite hosts. The same authors (1961) found that alightment of 2 species of aphids in the field occurred more in response to the long-wave energy reflected from the leaves than to the taxonomic status of the plant. Müller (1962) found that approximately equal numbers of 2 species of aphids landed on 5 different plants, and concluded that host selection did not take place during the initial approach, but only after alightment.

Johnson (1958) found several things about the habits of aphids which are pertinent to virus transmission: (1) Aphids alighting on plants normally spend some time wandering and probing, and then may or may not settle down to feed. (2) The shorter the flight, the shorter the time the aphids stay on the plant. (3) The less suitable the host, the more restless the aphids will be before settling down. He concluded that this restless type of behavior is particularly suitable for the transmission of plant viruses.

Sylvester (1958) found that non-persistent viruses, which can be rapidly acquired (in a few seconds) and rapidly inoculated, are also rapidly lost by aphids. The same author (1962) stated that transmission of mosaic viruses is accomplished by some type of stylet tip contamination, with the question of vector specificity unresolved. He believed that this transmission relies upon an interaction between virus, host plant cells, and vector's saliva.

Simons (1957) found that 2 types of field spread are involved in the transmission of the non-persistent aphid-borne pepper mosaic virus: 1) primary spread from outside to within the field, and 2) secondary spread within the field. He considered that the most important factors influencing spread were: 1) the numbers of alate vectors present; 2) vector efficiencies of the aphid species; 3) relative amounts of movement of the aphids; 4) the number of diseased plants present; and 5) climatological factors. According to him, the primary spread of pepper veinbanding mosaic was more serious in the spring than in fall and winter because more aphids and more diseased plants were in the area in the spring than in fall and winter. He also found that aphids could bring the virus from a distance of 800 to 1,000 feet.

Bradley (1959) found that Myzus persicae ceases to transmit potato virus Y during probing because the virus is removed from the stylet as it penetrates. He believed that aphids moving in the air remain able to transmit virus on their stylets longer than previously thought because they do not probe during this time.

Zaumeyer and Kearns (1936), in a study of bean mosaic, found 14 species of aphids on the plants, of which 8 were good vectors.

Swenson (1957) tested 17 species of aphids, and found that 16 were able to transmit the bean yellow mosaic virus. He believed that most of the aphids occurring on beans were potential vectors of the disease. Swenson and Nelson (1959) found 18 species of migrating aphids on gladiolus, but virtual absence of any colonization. In transmission studies they found that 6 species not previously recorded as vectors could transmit the cucumber mosaic virus in gladiolus.

Zaumeyer and Kearns (1936) found some positive correlation between the size of aphid populations on bean plants and the amount of bean mosaic spread, though at the end of the season, when the per cent mosaic in the fields was very high, fewer aphids transmitted more mosaic. Most of the aphids found on beans were the winged migrant forms of various species.

Broadbent (1950) found that numbers of Myzus persicae were correlated to a lesser degree with spread of rugose mosaic than with spread of leaf roll, perhaps because other aphid species also were vectors. Hollings (1955) found high positive correlations between catches of Myzus persicae and spread of rugose mosaic and leaf roll in potatoes, but low correlations with other aphid species.

Watson et al. (1951) found that beet mosaic virus increased with increasing numbers of Myzus persicae, but the relationship was not close enough to exclude the possibility of other vectors. After 6 years of observations Watson and Healy (1953) reported that coefficient of regressions of beet mosaic virus on numbers of Myzus persicae and Aphis fabae were not significant.

Jenkinson (1955) found positive correlations between numbers of alates of Myzus persicae and Brevicoryne brassicae and the spread of mosaic in broccoli based on very scant data. He also found significantly more mosaic in broccoli grown close to infected plants than in broccoli separated by at least one mile from sources of infection.

Dickson and Laird (1959) found, by correlating the different species of aphids caught on sticky traps with the spread of lettuce-mosaic, that when inefficient vectors were present, spread of mosaic did not occur. When there was an outbreak of mosaic, there was a rather high vector population. Laird and Dickson (1963) were not able to find any correlation between alate aphid populations and primary spread of tobacco etch virus and potato virus Y in peppers. However, secondary spread was significantly correlated with Myzus persicae to which the authors attributed all secondary disease spread.

## Traps for Aphid Population Studies

Kaloostian and Yeomans (1944) used sticky material on yellow painted wood panel traps for collection of pear psylla. Broadbent (1948) found that yellow traps coated with adhesive grease caught more aphids than white or black traps. Kaloostian (1961) found that yellow traps coated with Stikem® captured 10 times as many Homoptera and Diptera as those coated with Tanglefoot®.

Von-Profft (1939) almost always caught more aphids on sticky traps facing the direction of the wind. Johnson (1950) found differences between sticky traps and suction traps in evaluation of flying aphid populations, and believed that estimates of population density based on suction trap catches are likely to be more accurate.

Heathcote (1958) found that numbers of aphids caught on sticky traps decreased with increasing trap height. However, yellow water traps which were level with the tops of the plants in a potato field consistently caught more aphids than the ones at ground level which were within the crop.

Eastop (1955) found that Moericke yellow dish traps caught more aphids having dicotyledons as hosts than aphids having grasses or sedges as hosts. He caught 6.4 times as many Myzus persicae in yellow dish traps as in suction traps. This ratio for Rhopalosiphum maidis was .8 for females, and 2.0 for males. The ratio for Rhopalosiphum splendens was 1.3.

## Control of Stylet-Borne Viruses by Vector Control

Almost all attempts to control the spread of stylet-borne viruses by using insecticides have been made in small plot experiments. Jefferson and Eads (1951) reduced stock mosaic in one year more than 50% by spraying almost weekly with parathion. However, the following year parathion as well as other insecticides had no effect on stock mosaic incidence.

Broadbent et al. (1956) had good reduction of potato virus Y by spraying potato plants with DDT, endrin, schradan, mipafox, malathion, parathion and demeton every 10 to 14 days. Demeton in one year decreased potato virus Y by almost 75%, while in the next year by only 25%. About the same rate of decrease was obtained with the other insecticides. Dieldrin and toxaphene were ineffective.

Fry and Jacks (1956) found that foliage treatments of lindane, parathion, TEPP and soil treatment with schradan reduced the incidence of turnip mosaic. The most effective treatment was with parathion which reduced mosaic incidence from 94% to 33%.

Chalfant (1959) found partial control of cucumber mosaic in cucumbers by using parathion and soil and foliage applications of American Cyanamid 12008 and phorate. He also was able to reduce cabbage mosaic with foliage applications of phorate, American Cyanamid 12008 and parathion.

Shanks (1960) found that soil or foliage applications with systemic insecticides gave good reductions of cucumber mosaic virus. He also found that several insecticides, when tested for speed of action on Myzus persicae, required at least 1 1/2 hours to kill 90% of the alates when these were exposed 2 hours after treatment, and much longer to kill this amount 3 days later. He reported that parathion was attractive to viruliferous aphids and thereby increased the spread of potato Y. Münster and Murbach (1952) reported that winged aphids were attracted to the schradan treated plots in a randomized block experiment.

Kantack et al. (1961) found that demeton spray or DDT dust applied weekly or twice weekly to sweet potato foliage reduced field spread of cork disease by almost 50%. This reduction was obtained when almost half of the plants in the check plots were infected with cork disease. Some diseased plants were intentionally located in both treated and untreated plots to increase the opportunity for secondary spread. Little or no control was evident when the magnitude of spread into disease-free check plots was at a minimum.

Leuck et al. (1962) found that when dimethoate, phorate and Di-Syston were applied in plots of 1/2 acre, bean yellow mosaic was reduced from 81% in untreated plots to 13%, 23%, and 33%, respectively, in treated plots. Two applications of each insecticide were made at the rate of 2 pounds of insecticide per acre, one on January 31 and a second on March 13.

Heathcote and Ward (1963) found that treatments with DDT decreased the spread of cabbage black ring spot and cauliflower mosaic viruses in cauliflower seedlings and cauliflower mosaic virus in turnip seedlings in cages where alate aphids were released; however, the decrease was small. The same authors found that aphids had to be in contact with DDT-treated leaves for 15 minutes or more to suffer harm, and barely half of them died within 24 hours after exposure to treated leaves for 30 minutes.

Ingram *et al*. (1939) used pyrethrum and derris in combination with sulfur and nicotine sulfate in small sugarcane plots (.2 to .3 acres) but no treatment consistently reduced infestation. Charpentier (1956) attempted to control sugarcane mosaic in small plots by applying 1/4 pound of demeton per acre on April 13, May 10 and May 29, but by June 16 mosaic incidence averaged 2.1% in the treated plot and 2.9% in the check plots. Small amounts of insecticide were found in the molasses, syrup and sugar samples processed from the treated sugarcane.

Sylvester *et al*. (1959) found that there was little evidence that demeton acted in a truly systemic manner when applied weekly to beets since the new growth of the plants was susceptible to colonization of *Myzus persicae*, which comprised 95% of the aphids found on the plants. Klostermeyer (1953) found that a reduction of plant growth follows seed treatment of potatoes with schradan and demeton.

Dickson *et al*. (1949) applied DDT, benzene hexachloride and nicotine 3 times at weekly intervals to 10-acre blocks of cantaloupe on 3 farms during the time of maximum aphid flights, but were not able to obtain any measurable degree of control of cantaloupe mosaic.

## Plant Virus Inhibitors

Chester (1934) found that blood serum, egg albumin, milk and a tobacco plant extract when applied to plants reduced their susceptibility to viruses. Johnson (1941) found that whole milk inactivated several plant viruses even when diluted with 9 parts of water, and that skim milk and whey were just as effective as whole milk. He also stated that neither pasteurization nor boiling affected this property of milk. He also mentioned that additional unpublished data by R. W. Fulton showed that casein was the active agent concerned, and that lactoglobulin was a good virus inactivator but was present in too low a concentration in milk to be important in this respect.

Lucas and Hare (1959) found that lactalbumen, $\alpha$-lactoglobulin and $\beta$-lactoglobulin were weak inhibitors of tobacco mosaic virus, whereas casein and the crude whey protein fraction of bovine milk were much stronger inhibitors. None of these compounds at a concentration of approximately 2% had the inhibitory effect of skim or homogenized milk. Hare and Lucas (1959) found that when pepper plants were sprayed with milk and then mechanically inoculated with tobacco mosaic virus the percentages of plants subsequently showing symptoms were 10, 10 and 20 for plants which were inoculated immediately after spraying, 24 hours later and 48 hours later, respectively. Ninety-two per cent of the unsprayed plants which were inoculated subsequently showed symptoms.

Lucas (1959) recommended milk as the only practical means for control of tobacco mosaic. He stated that best results were obtained when tobacco plants were sprayed with milk before transplanting, and when workers dipped their hands in milk before handling the plants.

Lucas (1962) found that alfalfa and cucumber mosaic, potato X and Y, tobacco etch mosaic and ring spot viruses were strongly inhibited in greenhouse tests when juice from virus-infected plants was mixed with skim milk and rubbed on leaves of susceptible plants.

Anzalone (1962) found that infection by sugarcane mosaic virus was completely inhibited by milk when juices from virus-infected plants were mixed with milk and inoculated into healthy plants. When milk was used as a protective spray on sugarcane plants 24 hours before mechanical inoculation the development of mosaic symptoms was greatly reduced. He found that dilution of whole milk with water reduced the effectiveness of the milk treatments. However, he also found that milk was phytotoxic to young sugarcane plants. The same author (1962b) reported that sugarcane mosaic virus was inhibited in greenhouse tests when juice from mosaic plants was mixed with equal parts of methyl bromide or MC-2 (98% methyl bromide and 2% chloropicrin).

Shanks (1960) found in greenhouse studies that milk had no effect on cucumber mosaic virus and potato virus Y when inoculation was by aphid vectors. Bradley (1956) found that when the stylets of aphids passed through virus-free membranes of tobacco, onion or tulip plant epidermis or through "parafilm" put over tobacco leaves infected with virus Y, the aphids could not acquire the virus. Bradley _et al_. (1962) found that viruliferous _Myzus persicae_ which probed potato leaf disks coated with paraffin oil, dormant spray oil, octane, corn oil, or olive oil were able to transmit the virus only occasionally. However, they did not investigate how oils interfere with aphid transmission of virus Y.

# MATERIALS AND METHODS

## Seasonal Abundance of Aphids

The seasonal abundance of various aphid species was determined by identifying and counting aphids caught on sticky traps and found on sugarcane plants.

Sticky traps consisted of galvanized steel plates, 8 1/2 by 5 inches, painted sunny yellow and covered with Stikem® (a product containing 97% by weight of polymerized butene, isobutene and butane, and manufactured by Michel and Pelton Co., Oakland and Emeryville, California) on 4/5 of their total area. They were fastened by screws to stakes which had a series of holes drilled in them at one-foot intervals (Figure 1). These traps were always fastened on the stakes at a level about one foot above the tops of the sugarcane, which required them to be almost 15 feet above the ground when the plants were full grown. Stikem® was removed from the traps each week after aphids were identified and counted.

Most aphids were identified on the traps with the help of a binocular microscope. Aphids were counted and identified from only one-half of the total sticky surface of each trap. When identification of specimens on the traps was difficult, aphids were removed with a small brush moistened with xylene, put in a vial of xylene and allowed to stand for approximately 24 hours. Then they were placed momentarily

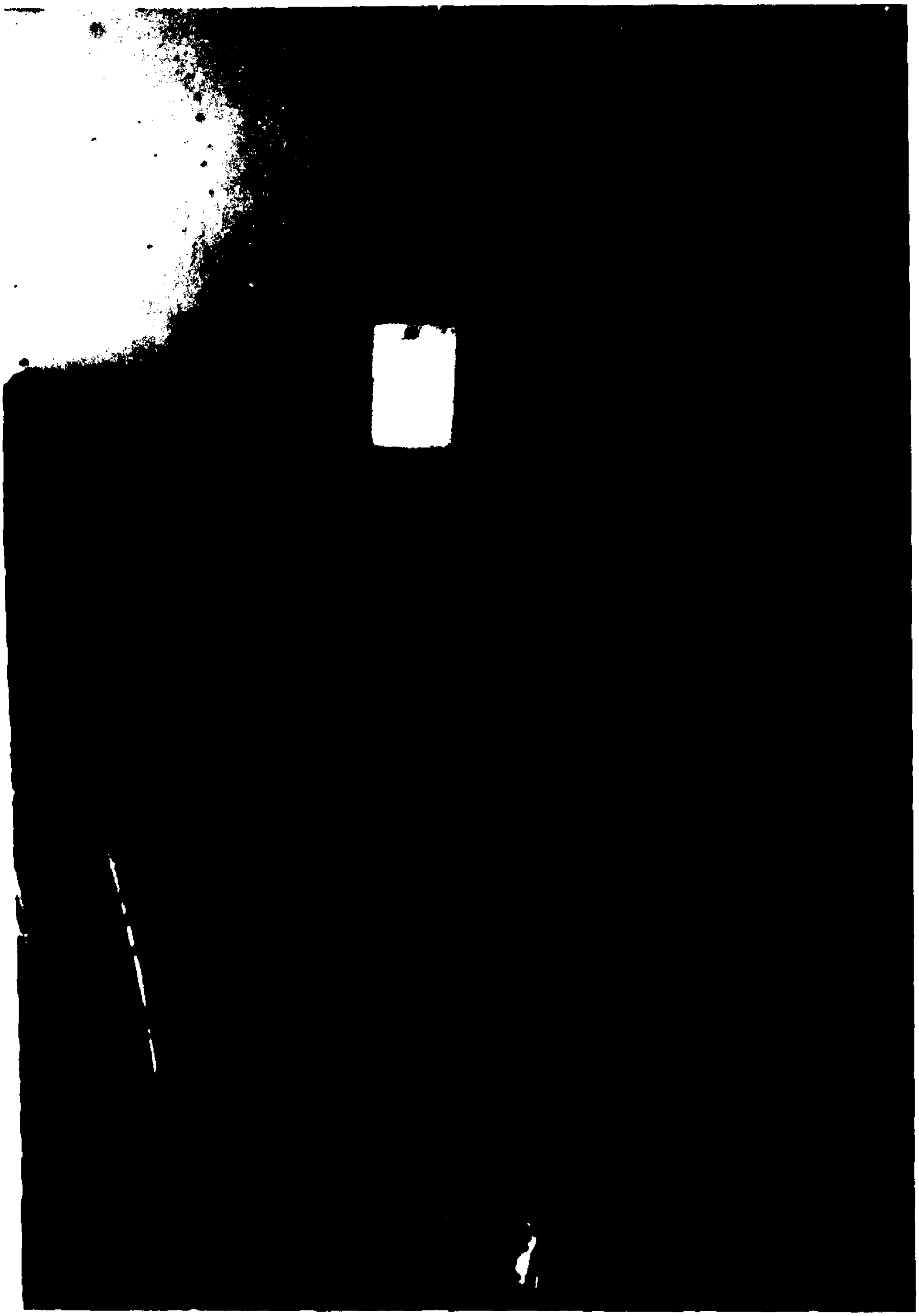

Figure 1. Sticky traps used to catch aphids in sugarcane fields.

on a piece of absorbent paper which absorbed surplus xylene before being stored in 70% alcohol. Aphids were mounted permanently as described by Boudreaux (1949), or temporary mounts were prepared using Hoyer's medium. Slides then were examined under a compound microscope.

At Brusly, Louisiana, every week from February 9 to September 29, 1962, 16 sticky traps were placed at approximately 50 foot intervals on the middle row of a 5-acre field plot to be treated with insecticides (Figure 2). Alternate traps faced opposite directions. Two more rows of 4 traps each, 18 feet apart, were located at each end of the center row of traps, perpendicular to this row and facing the nearest end of the plot. All of these traps were approximately 165 feet from the nearest edge of the treated plot.

Another 24 traps were placed around the outside of this field plot and facing away from it. All of these were located 30 feet outside the nearest border of the plot and were 100 feet apart. In each group of 24 traps 8 were facing north northeast, 4 west northwest, 8 south southwest and 4 east southeast.

At Donaldsonville, Louisiana, every week from October 4 to December 14, 1962, and from March 8 to August 9, 1963, and every second week from December 14, 1962 to March 8, 1963 and from August 9 to September 18, 1963, 20 freshly coated sticky traps were put in each of two 10-acre plots, one to be treated with insecticides and one untreated check. Figure 3 shows the arrangement of traps in one of these plots. The arrangement was the same in both plots.

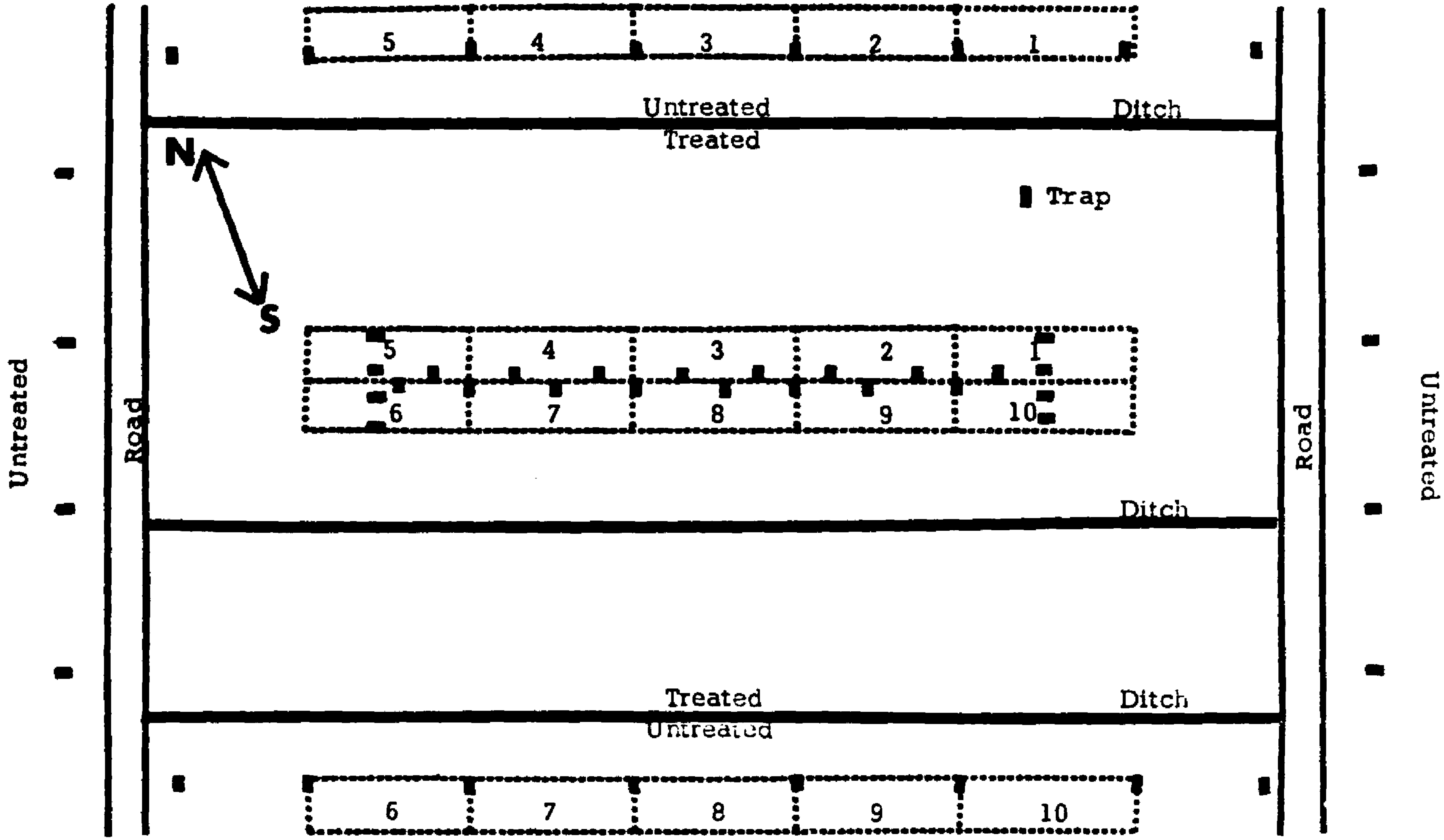


Figure 2. Diagram indicating trap positions and experimental design of demeton treated and untreated plots. Brusly, Louisiana, 1962.

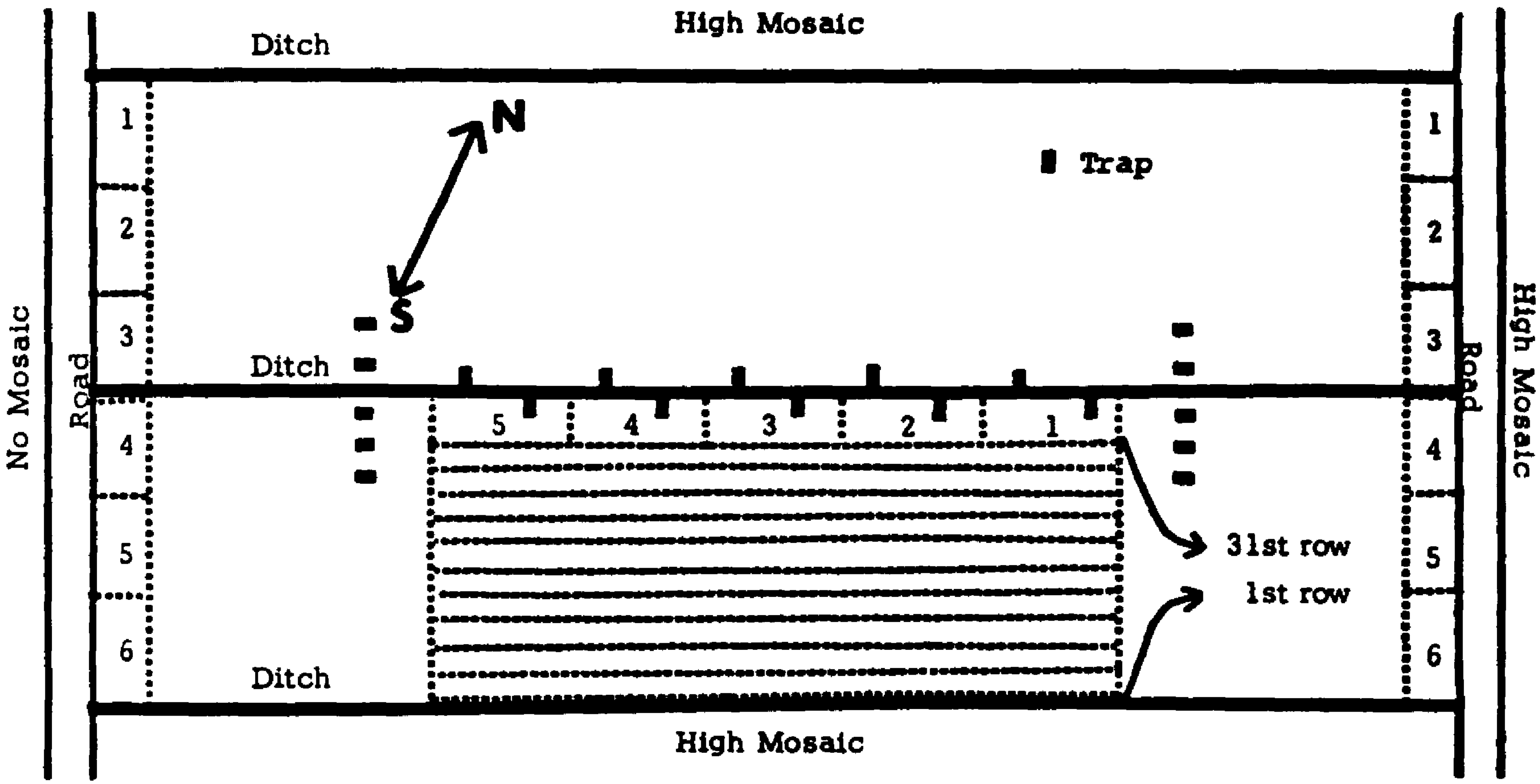


Figure 3. Diagram indicating trap positions and experimental design of untreated plot in demeton treated and untreated experiment and design of border effect experiment which was included in the same ten acre plot. Donaldsonville, Louisiana, 1962-63.

Ten traps were placed approximately 50 feet apart on the middle row of sugarcane. Two more rows of 5 traps each, 18 feet apart, were located at each end of the center row of traps, perpendicular to this row and facing the nearest end of the plot. All traps were approximately 215 feet from the nearest edges of the plots. In both groups of the 20 traps, 5 were facing north-northwest, 5 west-southwest, 5 south-southeast, and 5 east-northeast.

Aphids found on the plants in different experimental plots were removed with a moist camel's hair brush, put in 70% alcohol and brought to the laboratory for identification. Since the amount of time spent in the experimental plots each week was different at different seasons of the year, the numbers of aphids found on plants probably is not the best measure of seasonal abundance of each species.

Aphids were identified to species with the help of keys prepared by Boudreaux (1946) for the species of Louisiana. Occasionally, the work of Palmer (1952) also was consulted.

## Incidence of Mosaic

### Seasonal Incidence

The incidence of mosaic was determined periodically in all experimental plots including those used for insecticide, milk and casein applications at Brusly and at Donaldsonville. However, another experiment at Donaldsonville was designed to measure small increases in mosaic incidence which occurred from week to week in small plots of sugarcane planted on 4 different dates. Each planting was replicated 5 times in single-row plots 50 feet long with planting dates assigned to plots according to a randomized complete block experimental design. The 20 small rows of this experiment were adjacent to diseased cane of the variety N.Co. 310, approximately 18% of which showed mosaic symptoms during the fall of 1962. The plantings were made September 27, 1962, March 1, April 18 and July 11, 1963.

In the plots of this experiment the total numbers of stalks and the total numbers showing mosaic symptoms were recorded on each observation date, usually at one week intervals from the time symptoms first appeared in the spring until September 17, 1963.

The seed cane that was used for these plantings was C.P. 52-68, all from the same field on Oaklawn Plantation at Franklin, Louisiana. The seed cane that was used for the first 3 plantings was examined prior to cutting in late September and late November, 1962 and was found to be free of mosaic symptoms. Those stalks which were not planted in September were cut in November and buried from 1 1/2 to 2 feet in the ground to save them for the March and April plantings. It was necessary to remove the seed cane used for the third planting from the ground in the middle of March because it started sprouting. The stalks which had not rotted were cut into small pieces, put in perforated galvanized metal cans in alternating layers with a mixture of fine sand, vermiculite and a little water, and placed in a 60$^{\circ}$F. air-conditioned room. The seed cuttings were wet once a week and kept there until April, 1963, when they were planted. The seed cane used for the fourth planting was found to be free of symptoms and was cut July 10 and planted July 11, 1963.

### Border Effect

At Donaldsonville, 6 subplots 12 rows wide and 40 feet long were located on the east-northeast side of the 10-acre untreated plot close to the diseased cane, 66% of which showed mosaic symptoms August 2, 1963 (Figure 3); and 6 similar subplots were located on the west-southwest side adjacent to mosaic-free cane. These subplots at opposite ends of the large plot, were 920 feet apart. As is later indicated, the whole 10-acre plot was planted with C.P. 52-68 seed cane having low mosaic incidence (probably less than 2%). Fifty stalks in each subplot were selected randomly every 3 steps along the rows and were checked for mosaic symptoms on August 2, 1962.

## Control of Aphids and Mosaic

### Insecticides

The only insecticides used in these studies were demeton (0,0-diethyl 0(and S)- 2-(ethylthio)ethyl phosphorothioate) and Di-Syston® (0,0-diethyl S-2-(ethylthio) ethyl phosphorodithioate).

On February 9, 1962 a plot of 5.37 acres (335 feet wide by 700 feet long) was selected in a large sugarcane field for an insecticide experiment at Brusly, Louisiana (Figure 2). Sticky traps were set on this date as already described in the section on seasonal abundance of aphids. This plot and the area adjacent to it on 3 sides were planted in the fall of 1961 with heat-treated N.Co. 310 seed cane which showed 1.2% mosaic symptoms on May 4, 1962. The north-northwest side of the plot was adjacent to essentially mosaic-free heat-treated C.P. 52-68 plant cane.

From February 24 to August 23, the 5.37-acre plot was treated twice with granular Di-Syston and 10 times with demeton. Table II indicates times of applications, insecticide formulation, pounds per acre of technical insecticide applied and equipment used.

Observations to measure the incidence of mosaic symptoms in the treated plot were taken from 10 subplots, each consisting of 5 rows 100 feet long (Figure 2). The 10 subplots were arranged in a double row of 5 subplots each at the middle of the field and occupied a total area of 30,000 square feet. Observations to measure the incidence of mosaic in the adjacent untreated portions of this field were made in the 5 small plots 30 feet away from the north-northeast boundary of the treated plot, and 5 other small plots similarly located with respect to the south-southwest boundary of the treated plot. The size and shape of these 10 small plots were the same as the 10 subplots at the center of the large treated plot.

Mosaic incidence was determined in each subplot by examining randomly selected stalks, 3 or 4 paces apart, each week from May 4 to September 29, 1962. Fifty stalks in each subplot of the large treated

Table II. Insecticide applications made in a 5-acre sugarcane plot at Brusly, Louisiana, 1962.

| Date of Application | | Insecticides | Pounds Per Acre of Technical Insecticide | Equipment Used |
|---|---|---|---|---|
| February | 24 | Di-Syston (granules) 10% | 2.8 | Cyclone seeder |
| April | 20 | Di-Syston (granules) 10% | 2.6 | Cyclone seeder |
| May | 4 | Demeton 2#/gallon | 0.25 | Hi-Boy sprayer |
| May | 16 | Demeton 2#/gallon | 0.25 | Hi-Boy sprayer |
| May | 23 | Demeton 2#/gallon | 0.25 | Hi-Boy sprayer |
| May | 30 | Demeton 2#/gallon | 0.25 | Hi-Boy sprayer |
| June | 13 | Demeton 2#/gallon | 0.50 | Hi-Boy sprayer |
| June | 22 | Demeton 2#/gallon | 0.50 | Hi-Boy sprayer |
| June | 29 | Demeton 2#/gallon | 0.20 | Hi-Boy sprayer |
| July | 9 | Demeton 2#/gallon | 0.25 | Hi-Boy sprayer |
| August | 7 | Demeton 2#/gallon | 0.20 | Hi-Boy sprayer |
| August | 23 | Demeton 2#/gallon | 0.20 | Hi-Boy sprayer |

plot (a total of 500 stalks) and an equal number in the small untreated plots were examined each week.

On September 19, 1962, 2 plots each with an area of 9.86 acres (430 feet wide and 1,000 feet long) were planted with heat-treated C.P. 52-68 seed cane at Donaldsonville, Louisiana (Figure 3). Both plots were planted in a field of N.Co. 310 sugarcane 430 feet apart. The C.P. 52-68 seed cane came from the same farm, out of a field in which no mosaic symptoms could be found August 1, 1962. The N.Co. 310 sugarcane which surrounded the newly planted plots on all but one side was from 16% to 19% infected with mosaic, based on a count of visible symptoms in randomly selected stalks November 21, 1962. However, the west-southwest sides of these newly planted plots bordered on sugarcane of the varieties C.P. 47-193 and C.P. 36-13 in which no mosaic symptoms were found.

One of these plots was to be treated with insecticides and the other one left as an untreated check. In the treated plot, 24 airplane applications of 1/4 pound of demeton per acre were made at weekly intervals from October 11 to December 14, 1962 and from March 15 to June 22, 1963. One application was omitted on June 15. Di-Syston granules were broadcast February 15 and March 22, 1963 at the rate of 1.5 pounds of Di-Syston per acre per application.

Determinations of the incidence of mosaic symptoms in the treated and untreated plots were made in 5 subplots at the center and 12 subplots in the south-southeast half of each of the 2 large plots. Each of the 5 center subplots were 5 rows wide and 100 feet long. The 12 single row subplots in the south-southeast half of the 2 large plots were 500 feet long and located on every third row starting with the first row at the edge of the plot and counting to the center of the plot.

In each plot determination of mosaic incidence was estimated by examining stalks selected at random 3 or 4 steps apart in the rows. Fifty plants in each subplot were examined on each observation date in both the treated and untreated plots. Observations were made in the center subplots every week and in the subplots of the south-southeast halves of the large plots every 2 weeks.

Aphids found on plants at the time of inspections for mosaic were preserved for identification.

Aphids flying over the treated and untreated plots at Brusly and Donaldsonville were sampled by using sticky traps set in the centers of the plots as described in this chapter under the section on seasonal abundance of aphids.

### Milk and Casein

The first milk experiment was begun at Brusly, Louisiana in 1962. Seed cane of the variety C.P. 52-68 and apparently free of mosaic was planted in 14 rows 30 feet long on July 18, 1962. This experiment was planted adjacent on 3 sides to standing C.P. 52-68 sugarcane which showed mosaic symptoms in approximately 55% of the stalks at this time. Some of this diseased cane had been uprooted to make room for this experiment.

The first spray with milk was made when 20-25% of the stalks had emerged from the soil surface on July 28. Only every other row of plants was treated. The remaining 7 rows were left untreated for comparison.

Applications of milk were continued weekly until November 22, 1962 when the plants were cut to the ground. Applications were started again March 22, 1963 when the plants began to emerge from the ground, and were continued until July 7, 1963. For the first 2 applications, milk was diluted with water in the ratio of 3:1; in the next 2 applications a 1:1 mixture was used; 15 applications were made from August 18, 1962 to March 29, 1963 using a 1:3 mixture of milk and water. After this time, undiluted skim milk was applied weekly until June 7, 1963. A total of 19 applications of whole milk diluted with water and 10 applications with undiluted skim milk were made. Grade-A cow's milk and cow's skim milk from the Louisiana State University Department of Dairy Science were used for most applications.

Another experiment was started in March, 1963 at Donaldsonville, Louisiana. Here 30 feet of row were dug up on each of 18 alternate rows of highly diseased N.Co. 310, which appeared to be about 40% diseased at the time of emergence. Apparently disease-free C.P. 52-68 seed cane was planted in these rows after the uprooted plants had been carefully removed from the field. The seed cane used was of the same stock as that planted in the experiment in which cane was planted during 4 different seasons.

When plants began to emerge from the ground on April 10, weekly applications with skim milk and casein were started and continued until July 6, when a total of 13 applications had been made. Six rows were treated with skim milk, 6 rows with casein[1], and 6 rows were left untreated. A 3.5% solution of casein in water was used, while no water was added to the skim milk. Rows of each treatment were selected according to a randomized complete block design.

Weekly observations of mosaic incidence and aphids found on plants in both milk experiments were made, by checking all stalks for mosaic symptoms in all the plots just before the treatments were applied.

The amount of milk, skim milk and casein sprays used in both experiments was always sufficient to completely cover the plants until run-off occurred. A knap-sack sprayer was used in both cases.

## Statistical Analyses

The significance of differences between 2 means was determined by Student's t-test (Tables IX, X, XI, XVII, XVIII and XXIV). The significance of differences among more than 2 treatments arranged in a randomized complete block design was determined by the F-test (Table IX).

The significance of differences between check and demeton-treated

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[1]Casein soluble purified. Fisher Scientific Company. Manufacturing chemists. Cat. No. C-202.

plots on different dates, with regard to mosaic incidence, was determined by the F-test. These data were analysed as a factorial experiment with dates x treatments (Tables XXI, XXII and XXIII).

The significance of differences between check and milk-treated plots, and among check, milk-treated, and casein-treated plots was determined by co-variance analysis, since both numbers of plants and mosaic percentages varied from date to date (Tables XXV and XXVI). Where 3 treatments were involved, an orthogonal comparison of treatments was made (Snedecor, 1961). The comparisons were milk versus casein and check, and casein versus check.

Simple correlation coefficients were computed between numbers of the most abundant aphid species caught on traps in the untreated insecticide plot at Donaldsonville and mosaic incidence in the small plots of sugarcane planted on 4 different dates (Tables XII and XIV). All possible simple correlation coefficients between pairs of the most abundant aphid species were also computed (Table XVI).

Coefficients of partial regression of numbers of the most abundant species trapped weekly on weekly increases in mosaic incidence were computed by multiple correlation analysis (Table XIV).

Coefficients of determination were also computed from multiple correlation for successive groups of aphid species with selective deletion of the least correlated species from each successive group (Table XV).

One abbreviation and 2 symbols are used without explanation in some tables of results. The abbreviation, ns, indicates that the difference between means was not significant at the 5% level. Single asterisks (*) and double asterisks (**) indicate statistical significance at the 5% and 1% levels, respectively.

# RESULTS

## Seasonal Abundance of Aphids

### Aphids Caught on Traps

Seasonal abundance of flying aphid populations was determined by the use of sticky traps which were collected and reset at weekly intervals.

Table III shows the total numbers of aphids of different species which were found in the traps from February 9 to September 29, 1962 at Brusly, Louisiana, and from October 4, 1962 to September 18, 1963 at Donaldsonville, Louisiana, in both treated and untreated plots. Over 10,000 specimens were collected and identified. There were 69 species belonging to 30 genera of the 2 subfamilies, Aphidinae and Eriosomatinae. Sixty-one species were identified from Brusly and 45 from Donaldsonville. Thirty-seven species were found in both places.

Of the 7 known vectors of sugarcane mosaic, only *Acyrthosiphon pisum*, *Schizaphis graminum*, *Rhopalosiphum maidis* and *Hysteroneura setariae* were found in relative abundance on traps. Among the remaining known vectors, only 49 specimens of *Amphorophora sonchi*, 34 of *Dactynotus ambrosiae* and 3 of *Carolinaia cyperi* were trapped.

*Tetraneura hirsuta* (Baker) was identified by Miss M. Russell, U.S.D.A. Entomology Research Division, and is reported for the first time in Louisiana. Another species, *Drepanaphis utahensis* Knowlton and Smith, previously unrecorded in Louisiana, but collected and identified by Dr. H. B. Boudreaux since 1946, was collected during these studies.

Fifteen of the 69 species found in Table III comprised 92.7% of the total number of aphids trapped in both localities. More than 100 specimens of each of these most abundant species were caught in traps, with the exception of Hysteroneura setariae, a known vector, of which 71 specimens were caught.

Figure 4 and Table IV show that numbers of most aphids trapped in untreated plots at Brusly and Donaldsonville were relatively low from June until late February. During January and February, 1963, only 35 specimens were trapped. However, in the last 3 weeks of February, 1962, 255 aphids were trapped, 170 during the last week of the month.

Flying aphids were relatively abundant during the late winter and spring of both years. The period of high aphid population was longer during 1962 than during 1963. The occurrence of high populations started at the end of February, 1962, and continued almost until the end of May. During 1963, high populations occurred only in March and April.

The aphid population was relatively low during both summers. It was lower during the summer of 1963 than in 1962. The total number of aphids trapped during the fall of 1962 was higher than in either summer, but was much lower than in either spring.

Tables V and VI show that fewer aphids were caught on traps facing NNE at Brusly, and NNW at Donaldsonville, than on traps facing other directions. In most cases the numbers of aphids collected monthly were greater for the traps facing the general direction of prevailing winds.

Aphids Caught on Plants

Three hundred five specimens of aphids, comprising 232 winged adults and 73 nymphs belonging to 16 species, were caught on sugarcane plants. Three specimens belonging to the species *Hysteroneura setariae*, *Sipha flava* and *Tetraneura hirsuta* were found at Franklin, Louisiana on July 10, 1963. One specimen of *Chaitophorus viminalis* Monel was caught on sugarcane plants on the same date at Parks, Louisiana. This species was not found on traps or on plants in the experimental fields. Eleven winged aphids of *Tetraneura hirsuta* and 2 of *Dactynotus ambrosiae* were found October 29, 1963 on sugarcane plants growing on the Louisiana State University campus in Baton Rouge.

One hundred thirty-four specimens belonging to 9 species and including 119 winged adults and 15 nymphs, were found on different dates at Brusly, Louisiana during 1962 and 1963 (Table VII). One hundred fifty-four specimens belonging to 12 species and including 96 winged adults and 58 nymphs were found on different dates at Donaldsonville, Louisiana during 1962 and 1963 (Table VIII). Most of the nymphs found belonged to the species *Rhopalosiphum maidis* and *Hysteroneura setariae*. Thirteen of the 14 species which were found on sugarcane plants at Brusly and Donaldsonville are among the 15 most abundant species caught on the traps at both locations.

Comparisons should not be made of the numbers of aphids found on different dates since the time spent collecting was not always the same. Aphids were found on the plants during the entire period when sugarcane was out of the ground, even when it was half dead on December 14, 1962.

Most Abundant Species

The 15 species found in greatest abundance as winged adults in sugarcane fields during these studies are discussed here in alphabetical order. In this section only aphids trapped in untreated plots are considered.

Flying populations of the pea aphid, *Acyrthosiphon pisum*, occurred in both years during late winter and spring (Table IV, Figure 5). This species was most abundant at Donaldsonville, where 494 specimens were collected. More than 80% of these aphids were trapped during April. This species was found only once on sugarcane plants in April, 1963 (Table VIII).

The cotton aphid, *Aphis gossypii*, was found on the traps at both locations almost the year around, but its seasonal abundance was not the same in the 2 locations (Table IV, Figure 6). At Brusly it was present in the spring and most abundant during summer, while at Donaldsonville, it was most abundant during spring, present during summer, and moderately abundant in the fall. It was found on sugarcane plants in April at both places (Tables VII and VIII).

The corn root aphid, *Aphis maidiradicis* Forbes, was found on traps in all months except January, September and October. Almost 95% of the trapped population occurred during March, April and May (Table IV, Figure 7). Twenty specimens were found on sugarcane plants, of which 15 were caught during April in both locations (Tables VII and VIII).

The cowpea aphid, *Aphis medicaginis*, was one of the most abundant species found on traps and was found the year around. However, it was most abundant during late winter and spring when about 98% of the trapped aphids was caught (Table IV, Figure 8). Specimens were found on sugarcane plants only at Donaldsonville where 10 were caught, 9 during March and April (Table VIII).

The elder aphid, *Aphis sambucifoliae* Fitch, was one of the least abundant species among those chosen for discussion (Table IV, Figure 9). At Brusly 31 of the 46 specimens trapped were caught during April. At Donaldsonville only 10 specimens were caught. This species was not found on sugarcane plants.

The rusty plum aphid, *Hysteroneura setariae*, was the least abundant species found on traps among those chosen to discuss, and it was almost completely absent at Brusly (Table IV, Figure 10). At Donaldsonville it was trapped mostly during fall, and in small numbers during spring and summer. However, on sugarcane plants at Donaldsonville it was one of the most abundant species found (Table VIII). Thirty-one nymphs and 28 winged adults were found on sugarcane plants in this field during November, April, June and August.

The green peach aphid, Myzus persicae, occurred on traps mostly during late winter and spring, and again in low numbers during late fall (Table IV, Figure 11). Four specimens were found on sugarcane plants at both locations during March, April and May (Tables VII and VIII).

The apple grain aphid, Rhopalosiphum fitchii (Sanderson), was one of the less abundant species among those chosen for discussion (Table IV, Figure 12). At Brusly it was present on traps in late winter and most abundant during spring, while at Donaldsonville it was most abundant in December. Four specimens were found on sugarcane plants at Donaldsonville during March and April (Table VIII).

The corn leaf aphid, Rhopalosiphum maidis, was caught on traps from late April until the end of the year, but always in low numbers (Table IV, Figure 13). It was not a relatively abundant species on the traps, but it was found to be the most abundant species on sugarcane plants. Eighty-four winged adults were collected on sugarcane plants from both locations (Tables VII and VIII). As on traps, those aphids were caught on sugarcane plants from late April until the end of the year. In addition to the winged adults, 40 nymphs were caught on sugarcane plants. Of these, 5 were found October 17 in a colony at Brusly. Most of the other nymphs were caught on sugarcane plants close to the ditchbanks during fall, when they probably had just left the dying Johnson grass, Sorghum halepense (L.) Pers.

The turnip aphid, Rhopalosiphum pseudobrassicae, was one of the most abundant species, and was caught on traps in great abundance during a short period in late winter and early spring, and in small numbers intermittently during the rest of the year (Table IV, Figure 14). More than 70% of the total number of turnip aphids were trapped during March. Although found in such abundance on traps, the turnip aphid was never found on sugarcane plants at either location.

The Mediterranean grain aphid, *Rhopalosiphum splendens* (Theobald) was found all during the year on the traps (Table IV, Figure 15). During summer and mid-winter it was less abundant than at other times. There was a difference between locations in the length of time that this species was abundant. At Brusly considerable numbers of aphids were trapped from February to mid-July, while at Donaldsonville most aphids were trapped during fall and again during March and April. A total of 12 winged adults and one nymph were found on sugarcane plants at different times of year (Tables VII and VIII). It is interesting to note that this species was found December 14 on half-dead yellowish sugarcane leaves after a hard freeze.

The greenbug, *Schizaphis graminum*, was most abundant on traps during March and April when almost 85% of the trapped aphids were caught (Table IV, Figure 16). It generally was not caught on traps during summer and most of the winter. This species was more abundant at Brusly where 159 specimens were caught on traps, compared to 43 at Donaldsonville. Only one specimen was found on sugarcane plants (Table VII).

The yellow sugarcane aphid, Sipha flava, was one of the least abundant species found on traps among those chosen for discussion (Table IV, figure 17). It was trapped during every month except January, February and November. A little greater flying activity was shown during spring than during other seasons at Brusly. Three winged adults and one nymph were found on sugarcane plants (Tables VII and VIII). No colony was ever found.

Table IV and Figure 18 show that Tetraneura hirsuta was found on traps at both locations, but its seasonal abundance was not the same at the 2 locations. At Brusly it was found in greatest abundance during summer, but at Donaldsonville it was found in very low numbers during the summer, and in greatest abundance during late fall and early winter. It was relatively scarce in both places during spring. It was the second, after Rhopalosiphum maidis, in abundance on sugarcane plants. Of the 43 specimens caught on plants, 40 were found at Brusly mostly during summer (Tables VII and VIII).

The spotted alfalfa aphid, Therioaphis maculata (Buckton), was present on traps from the beginning of the spring to the beginning of summer, with maximum abundance occurring from late April until early June (Table IV, Figure 19). The length of time that it occurred on traps in relative abundance was shorter at Donaldsonville than at Brusly (Table IV, Figure 19). It was found only once on sugarcane plants (Table VII).

Table III. Numbers of aphids of different species caught on sticky traps during 1962 at Brusly, Louisiana and during 1962-63 at Donaldsonville, Louisiana.

| | Scientific Names | Common Names | Total Numbers Caught |
|---|---|---|---|
| | Subfamily Aphidinae | | |
| | Tribe Aphidini | | |
| 1. | Acyrthosiphon pisum (Harris) | Pea aphid | 1169 |
| 2. | Amphorophora crataegi (Monell) | Four-spotted hawthorne aphid | 2 |
| 3. | Amphorophora sonchi (Oestlund) | | 49 |
| 4. | Aphis asclepiadis Fitch | | 3 |
| 5. | Aphis cephalanthi Thomas | | 29 |
| 6. | Aphis coreopsidis (Thomas) | | 3 |
| 7. | Aphis fabae Scopoli | Bean aphid | 3 |
| 8. | Aphis gossypii Glover | Cotton or melon aphid | 649 |
| 9. | Aphis helianthi Monell | Dogwood or sunflower aphid | 24 |
| 10. | Aphis illinoisensis Shimer | Grapevine aphid | 1 |
| 11. | Aphis maidiradicis Forbes | Corn root aphid | 635 |
| 12. | Aphis medicaginis Koch | Cowpea aphid | 1891 |
| 13. | Aphis monardae Oestlund | | 10 |
| 14. | Aphis rhamni Fonscolombe | | 5 |
| 15. | Aphis rociadae Cockerell | Russet-colored larkspur aphid | 10 |
| 16. | Aphis rubifolii (Thomas) | | 10 |
| 17. | Aphis sambucifoliae Fitch | Elder aphid | 142 |
| 18. | Aphis tulipae Fonscolombe | Tulip aphid | 2 |
| 19. | Aphis vernoniae Thomas | | 14 |
| 20. | Aphis sp. | | 20 |

Table III (cont.)

| | Scientific Names | Common Names | Total Numbers Caught |
|---|---|---|---|
| 21. | Brevicoryne brassicae (Linnaeus) | Cabbage aphid | 19 |
| 22. | Capitophorus bragii (Gillette) | Oleander thistle aphid | 48 |
| 23. | Capitophorus hippophaes (Walker) | | 66 |
| 24. | Carolinaia cyperi Ainslie | Sedge aphid | 3 |
| 25. | Carolinaia rhois Tissot | | 17 |
| 26. | Dactynotus ambrosiae (Thomas) | Brown ambrosia aphid | 34 |
| 27. | Dactynotus tissoti (Boudreaux) | | 3 |
| 28. | Hysteroneura setariae (Thomas) | Rusty plum aphid | 71 |
| 29. | Idiopterus violae Pergande | | 1 |
| 30. | Macrosiphum avenae (Fabricius) | English grain aphid | 7 |
| 31. | Macrosiphum carpinicolens Patch | | 2 |
| 32. | Macrosiphum euphorbiae (Thomas) | Potato aphid | 14 |
| 33. | Macrosiphum sp. | | 2 |
| 34. | Myzus persicae (Sulzer) | Green peach aphid | 510 |
| 35. | Rhopalosiphum fitchii (Sanderson) | Apple grain aphid | 195 |
| 36. | Rhopalosiphum maidis (Fitch) | Corn leaf aphid | 130 |
| 37. | Rhopalosiphum nymphaeae (Linnaeus) | Waterlily aphid | 3 |
| 38. | Rhopalosiphum pseudobrassicae (Davis) | Turnip aphid | 1689 |
| 39. | Rhopalosiphum rhois Monell | Monell's sumach aphid | 1 |
| 40. | Rhopalosiphum rufomaculatum (Wilson) | Pale chrysanthemum aphid | 2 |

Table III (cont.)

| | Scientific Names | Common Names | Total Numbers Caught |
|---|---|---|---|
| 41. | Rhopalosiphum serotinae Oestlund | | 5 |
| 42. | Rhopalosiphum spendens (Theobald) | Mediterranean grain aphid | 1010 |
| 43. | Rhopalosiphum sp. | | 3 |
| 44. | Schizaphis graminum (Rondani) | Greenbug | 412 |
| | Tribe Callipterini | | |
| 45. | Chaitophorus longipes Tissot | | 36 |
| 46. | Chaitophorus minutes (Tissot) | | 29 |
| 47. | Drepanaphis acerifolii (Thomas) | Maple aphid | 3 |
| 48. | Drepanaphis utahensis Knowlton and Smith | | 1 |
| 49. | Drepanaphis sp. | | 5 |
| 50. | Iziphya flabella (Sanborn) | | 45 |
| 51. | Lachnochaitophopus obscurus (Tissot) | | 1 |
| 52. | Melanocallis caryaefoliae Davis | Black pecan aphid | 1 |
| 53. | Monellia costalis (Fitch) | Black-margined aphid | 1 |
| 54. | Myzocallis discolor (Monell) | Eastern dusky-winged oak aphid | 9 |
| 55. | Myzocallis punctata (Monell) | Clear-winged oak aphid | 9 |
| 56. | Myzocallis walshii (Monell) | Black-bordered oak aphid | 22 |
| 57. | Therioaphis maculata (Buckton) | Spotted alfalfa aphid | 256 |
| 58. | Therioaphis trifolii (Monell) | Yellow clover aphid | 6 |
| 59. | Periphyllus populicolus (Thomas) | Cloudy winged cottonwood leaf aphid | 15 |
| 60. | Sipha flava (Forbes) | Yellow sugarcane aphid | 149 |

Table III (cont.)

| | Scientific Names | Common Names | Total Numbers Caught |
|---|---|---|---|
| | Tribe Lachini | | |
| 61. | Anoecia graminis Gillete and Palmer | | 35 |
| 62. | Cinara carolina Tissot | | 8 |
| 63. | Cinara longispinosa Tissot | | 1 |
| | Subfamily Eriosomatinae | | |
| | Tribe Eriosematini | | |
| 64. | Eriosoma lanigera (Hausmann) | | 1 |
| 65. | Tetraneura hirsuta (Baker) | | 442 |
| | Tribe Pemphigini | | |
| 66. | Pemphigus longicornis Maxson | | 4 |
| 67. | Pemphigus populitransversus Riley | Poplar petiole gull aphid | 77 |
| 68. | Pemphigus sp. | | 2 |
| | Tribe Prociphilini | | |
| 69. | Prociphilus fraxinifolii (Riley) | Leaf-curl ash aphid | 8 |
| | | Total | 10,084 |

Classification and identification follows that of Boudreaux (1946)

Table IV. Monthly abundance of aphid species most frequently caught on sticky traps in untreated plots at Brusly and at Donaldsonville, Louisiana, 1962-63.[a]

| Species | Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acyrthosiphon pisum | 1962 | - | 8 | 14 | 49 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1963 | 1 | 0 | 7 | 422 | 64 | 0 | 0 | 0 | 0 | - | - | - |
| Aphis gossypii | 1962 | - | 3 | 14 | 6 | 7 | 17 | 14 | 38 | 35 | 38 | 6 | 13 |
| | 1963 | 1 | 1 | 46 | 91 | 9 | 1 | 3 | 0 | 2 | - | - | - |
| Aphis maidiradicis | 1962 | - | 4 | 23 | 59 | 20 | 1 | 1 | 3 | 0 | 0 | 3 | 2 |
| | 1963 | 0 | 0 | 22 | 161 | 59 | 1 | 0 | 0 | 0 | - | - | - |
| Aphis medicaginis | 1962 | - | 48 | 134 | 89 | 206 | 25 | 3 | 0 | 0 | 5 | 6 | 2 |
| | 1963 | 0 | 0 | 128 | 305 | 22 | 2 | 2 | 1 | 1 | - | - | - |
| Aphis sambucifoliae | 1962 | - | 3 | 8 | 31 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1963 | 0 | 0 | 1 | 7 | 1 | 1 | 0 | 0 | 0 | - | - | - |
| Hysteroneura setariae | 1962 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 | 5 | 9 |
| | 1963 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 0 | 0 | - | - | - |
| Myzus persicae | 1962 | - | 2 | 16 | 32 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 4 |
| | 1963 | 0 | 0 | 175 | 29 | 1 | 0 | 0 | 0 | 0 | - | - | - |
| Rhopalosiphum fitchii | 1962 | - | 2 | 22 | 38 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| | 1963 | 3 | 0 | 4 | 6 | 0 | 0 | 0 | 0 | 0 | - | - | - |
| Rhopalosiphum maidis | 1962 | - | 0 | 0 | 2 | 10 | 8 | 5 | 6 | 6 | 6 | 3 | 3 |
| | 1963 | 0 | 0 | 0 | 4 | 13 | 5 | 4 | 0 | 2 | - | - | - |

Table IV (cont.)

| Species | Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rhopalosiphum pseudobrassicae | 1962 | - | 140 | 224 | 5 | 1 | 0 | 14 | 3 | 0 | 2 | 5 | 7 |
| | 1963 | 11 | 8 | 421 | 21 | 2 | 0 | 0 | 0 | 0 | - | - | - |
| Rhopalosiphum splendens | 1962 | - | 23 | 61 | 58 | 45 | 13 | 8 | 0 | 6 | 61 | 44 | 50 |
| | 1963 | 4 | 3 | 40 | 59 | 8 | 2 | 6 | 6 | 3 | - | - | - |
| Schizaphis graminum | 1962 | - | 16 | 107 | 34 | 2 | 0 | 0 | 0 | 0 | 2 | 4 | 2 |
| | 1963 | 0 | 0 | 12 | 21 | 2 | 0 | 0 | 1 | 0 | - | - | - |
| Sipha flava | 1962 | - | 0 | 11 | 15 | 14 | 4 | 3 | 3 | 5 | 4 | 0 | 1 |
| | 1963 | 0 | 0 | 0 | 4 | 2 | 2 | 8 | 1 | 0 | - | - | - |
| Tetraneura hirsuta | 1962 | - | 0 | 2 | 9 | 7 | 10 | 37 | 45 | 42 | 13 | 41 | 60 |
| | 1963 | 3 | 0 | 0 | 6 | 13 | 0 | 3 | 1 | 1 | - | - | - |
| Therioaphis maculata | 1962 | - | 0 | 4 | 14 | 17 | 8 | 5 | 0 | 0 | 0 | 0 | 0 |
| | 1963 | 0 | 0 | 0 | 6 | 79 | 5 | 0 | 0 | 0 | - | - | - |
| Miscellaneous | 1962 | - | 6 | 30 | 74 | 42 | 9 | 12 | 6 | 11 | 36 | 15 | 7 |
| | 1963 | 0 | 0 | 3 | 53 | 50 | 11 | 2 | 3 | 1 | - | - | - |
| Total | 1962 | - | 255 | 670 | 515 | 391 | 95 | 102 | 104 | 106 | 183 | 137 | 172 |
| | 1963 | 23 | 12 | 859 | 1200 | 325 | 31 | 28 | 13 | 10 | - | - | - |

[a]Aphids caught from February 9 to September 29, 1962 were from Brusly, while the rest were trapped at Donaldsonville, Louisiana.

Table V. Seasonal directions of prevailing winds and average numbers of aphids caught per trap, on traps facing different directions, Brusly, Louisiana, February 9 to September 29, 1962.

| | Average Aphids Per Trap | | | | Prevailing Winds[a] | |
|---|---|---|---|---|---|---|
| Month | NNE | WNW | SSW | ESE | Baton Rouge | New Orleans |
| February | 2.0 | 4.0 | 19.0 | 17.7 | S | SSE |
| March | 21.6 | 50.4 | 27.4 | 19.0 | NW | NNW |
| April | 14.5 | 23.0 | 21.0 | 34.7 | SE | SSE |
| May | 3.9 | 10.0 | 27.2 | 25.5 | S | SSE |
| June | 2.6 | 6.7 | 3.7 | 4.2 | ESE | SSE |
| July | 3.8 | 5.8 | 5.5 | 1.3 | W | WSW |
| August | 4.8 | 4.5 | 2.9 | 6.3 | NE | NE |
| September | 2.4 | 12.3 | 1.9 | 5.8 | NE | NE |
| Total per trap | 55.6 | 116.7 | 108.6 | 114.5 | | |

[a]U. S. Dept. of Commerce Weather Bureau (1962).

Table VI. Seasonal directions of prevailing winds and average numbers of aphids caught per trap, on traps facing different directions, Donaldsonville, Louisiana, October, 1962 to September, 1963.

| | Average Aphids Per Trap | | | | Prevailing Winds[a] | |
|---|---|---|---|---|---|---|
| Month | NNW | WNW | SSE | ENE | Baton Rouge | New Orleans |
| October | 8.2 | 9.4 | 7.2 | 11.8 | ESE | ENE |
| November | 5.4 | 4.2 | 3.6 | 14.2 | NE | ENE |
| December | 5.4 | 6.4 | 6.8 | 15.8 | NNE | NE |
| January | .6 | 1.0 | 1.2 | 1.8 | NNW | ENE |
| February | .6 | 1.0 | .6 | .2 | N | NNE |
| March | 21.2 | 59.2 | 62.2 | 29.2 | S | S |
| April | 38.0 | 77.6 | 70.0 | 54.4 | S | S |
| May | 14.6 | 15.0 | 19.6 | 15.8 | SW | SW |
| June | 1.2 | 1.8 | 1.6 | 1.6 | SW | SW |
| July | 1.2 | 1.4 | 2.0 | 1.0 | SW | SW |
| August | .8 | .8 | .4 | .6 | SW | WSW |
| September | .6 | .2 | .4 | .8 | ENE | ENE |
| Total per trap | 97.8 | 178.0 | 175.6 | 147.2 | | |

[a]U. S. Dept. of Commerce Weather Bureau (1962, 1963).

Table VII. Aphids found on sugarcane plants at Brusly, Louisiana during different months of 1962 and 1963.

| | | 1962 | | | | | | | 1963 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Stages | Apr. | June | July | Aug. | Sept. | Oct. | Nov. | Apr. | May | June | Total |
| Aphis gossypii | Adults | | | | | | | | 1 | | | 1 |
| Aphis maidiradicis | Adults | 1 | | | | | | | 7 | | | 8 |
| Aphis sp. | Adults | | 1 | | | | | | | | | 1 |
| Myzus persicae | Adults | 1 | | | | | | | | | | 1 |
| Rhopalosiphum maidis | Adults | | 14 | 12 | 27 | 2 | 2 | 1 | | | 4 | 62 |
| | Nymphs | | | | | | 5 | 7 | 1 | 1 | | 14 |
| Rhopalosiphum splendens | Adults | | 2 | | | | | 1 | | | | 3 |
| | Nymphs | 1 | | | | | | | | | | 1 |
| Sipha flava | Adults | | | | | 2 | | | | | | 2 |
| Tetraneura hirsuta | Adults | | | 12 | 17 | 9 | 1 | 1 | | | | 40 |
| Therioaphis maculata | Adults | 1 | | | | | | | | | | 1 |
| Total | Adults | 3 | 17 | 24 | 44 | 13 | 3 | 3 | 8 | | 4 | 119 |
| | Nymphs | 1 | | | | | 5 | 7 | 1 | 1 | | 15 |

Table VIII. Aphids found on sugarcane plants at Donaldsonville, Louisiana, during different months of 1962 and 1963.

| Species | Stages | 1962 Oct. | 1962 Nov. | 1962 Dec. | 1963 Mar. | 1963 Apr. | 1963 May | 1963 June | 1963 July | 1963 Aug. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acyrthosiphon pisum | Adults | | | | | 1 | | | | | 1 |
| Aphis gossypii | Adults | | | | | 1 | | | | | 1 |
| Aphis maidiradicis | Adults | | | | 1 | 8 | 3 | | | | 12 |
| Aphis medicaginis | Adults | | 1 | | 6 | 3 | | | | | 10 |
| Hysteroneura setariae | Adults | | 2 | | | 2 | | 1 | 21 | 3 | 29 |
| | Nymphs | | | | | | | | 31 | | 31 |
| Myzus persicae | Adults | | | | 2 | | 1 | | | | 3 |
| Rhopalosiphum fitchii | Adults | | | | 3 | 1 | | | | | 4 |
| Rhopalosiphum maidis | Adults | | 9 | | | 3 | 3 | 2 | 4 | 1 | 22 |
| | Nymphs | | 20 | 1 | | | | 1 | 4 | | 26 |
| Rhopalosiphum splendens | Adults | | 1 | 1 | 4 | 2 | | | | | 9 |
| Schizaphis graminum | Adults | | | | | 1 | | | | | 1 |
| Sipha flava | Adults | | | | | | | | 1 | | 1 |
| | Nymphs | | | | | | | 1 | | | 1 |
| Tetraneura hirsuta | Adults | 1 | 2 | | | | | | | | 3 |
| Total | Adults | 1 | 15 | 1 | 16 | 22 | 7 | 3 | 27 | 4 | 96 |
| | Nymphs | | 20 | 1 | | | | 2 | 35 | | 58 |

Figures 4-19. Numbers of aphids caught on sticky traps during 1962 at Brusly, Louisiana and during 1962-63 at Donaldsonville, Louisiana.

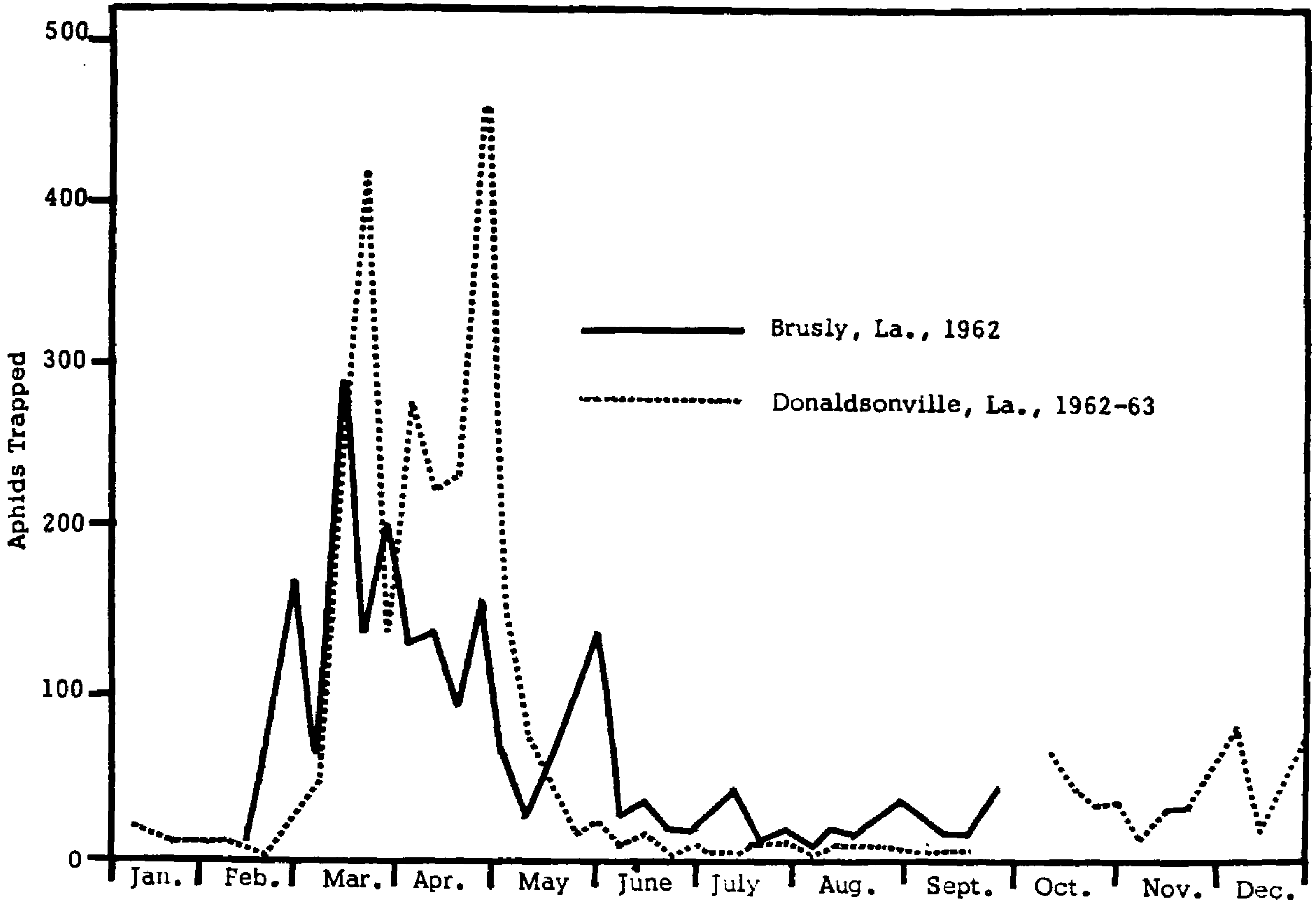


Figure 4. Total aphids.

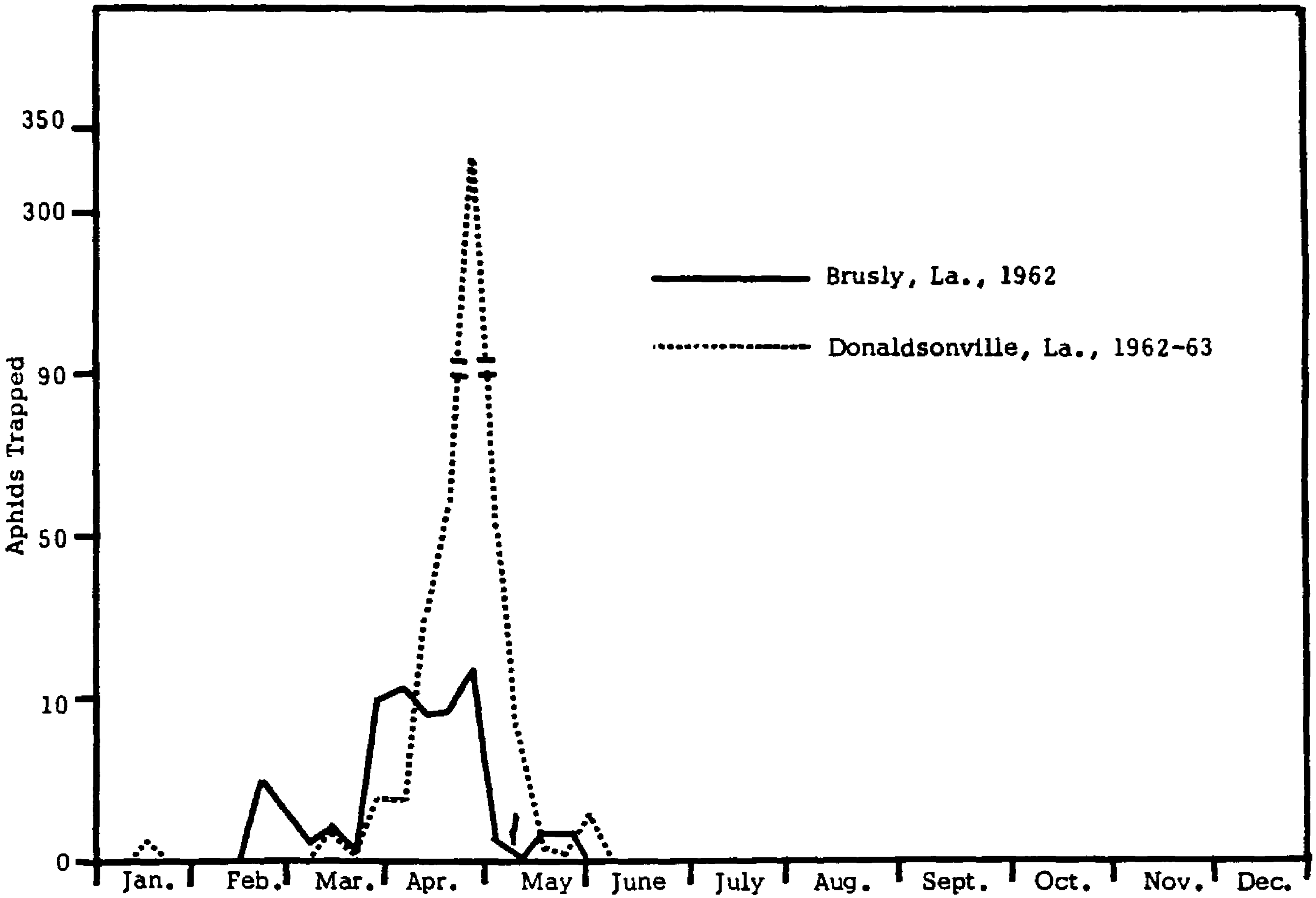


Figure 5. Acyrthosiphon pisum (Harris), pea aphid.

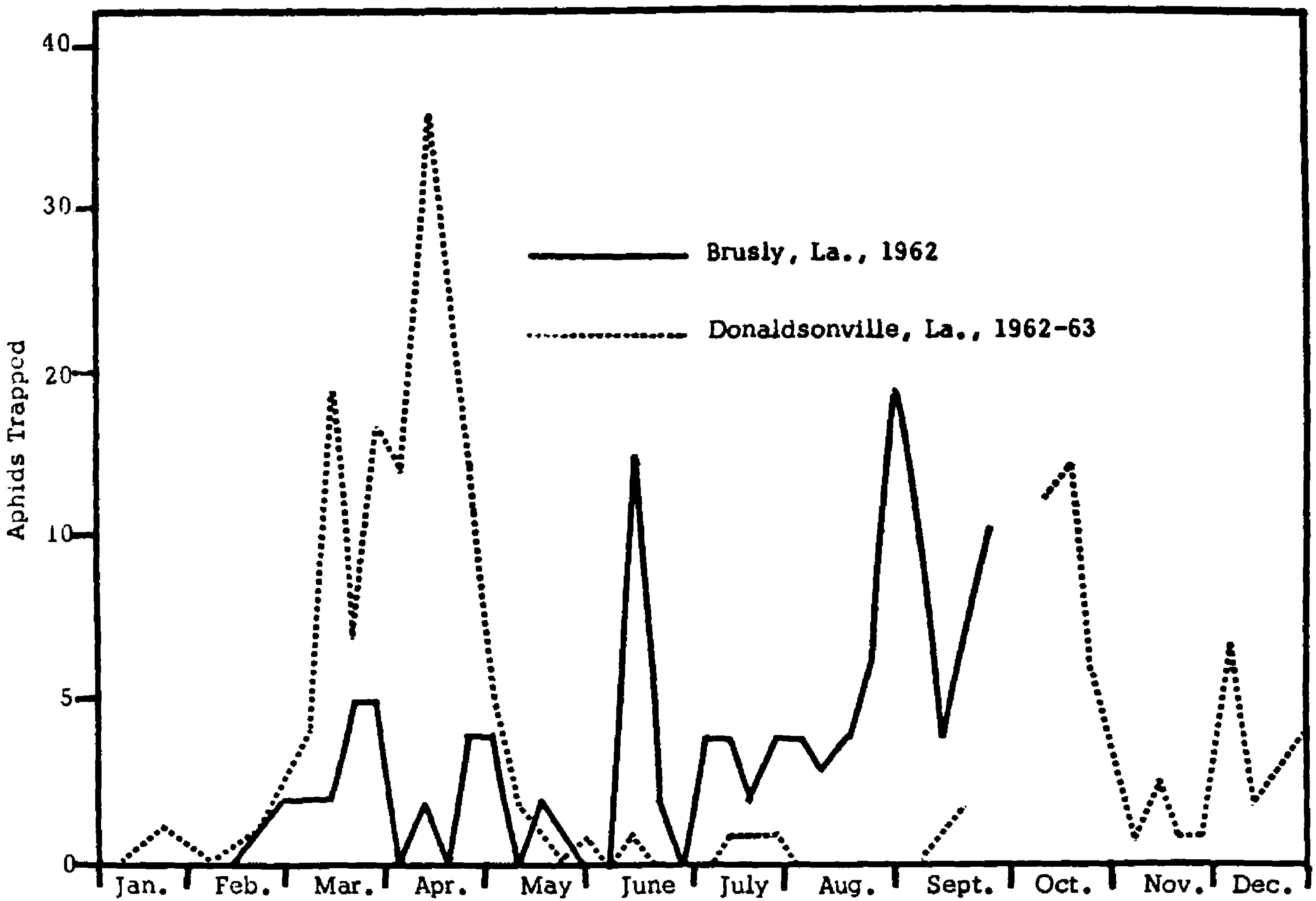


Figure 6. Aphis gossypii (Glover), cotton or melon aphid.

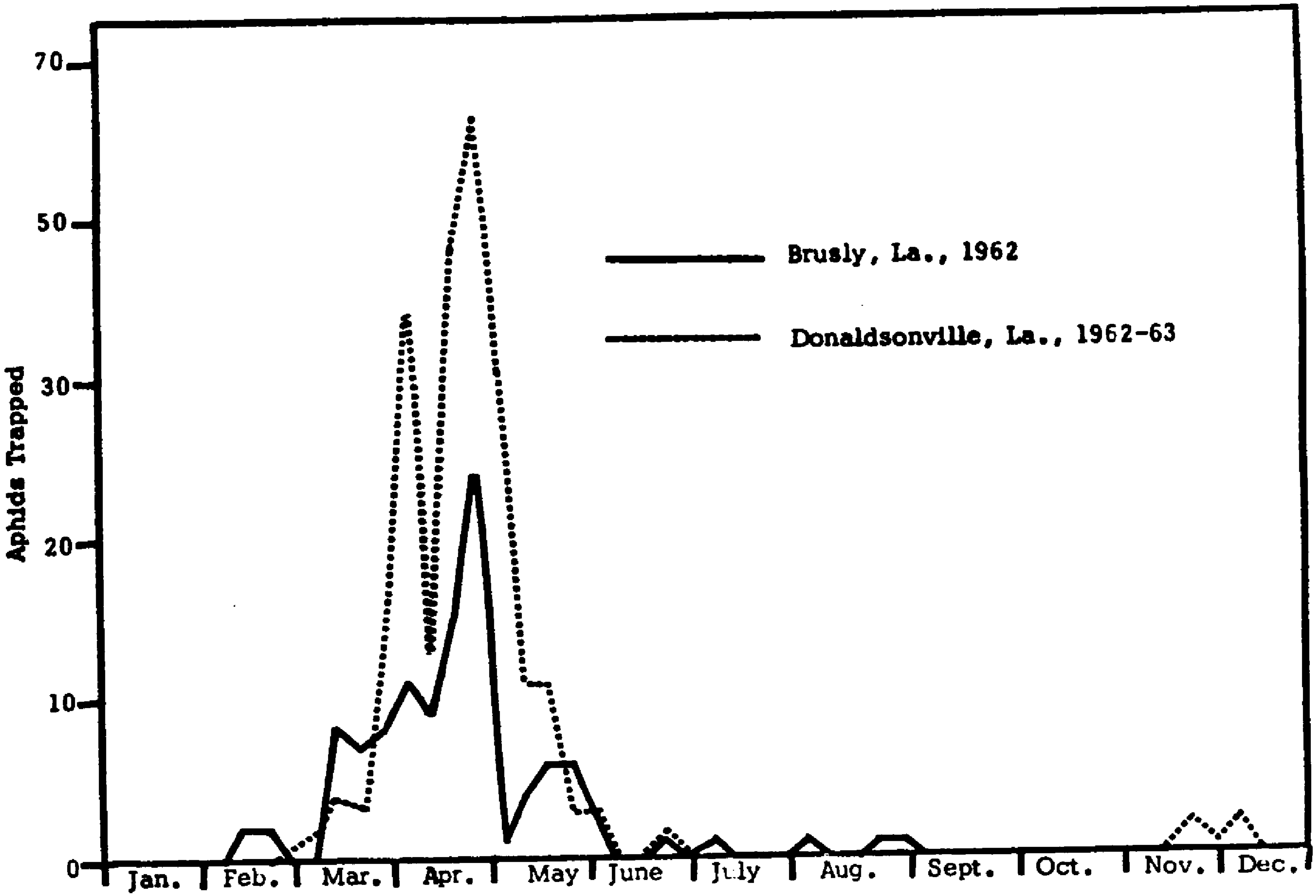


Figure 7. _Aphis maidiradicis_ Forbes, corn root aphid.

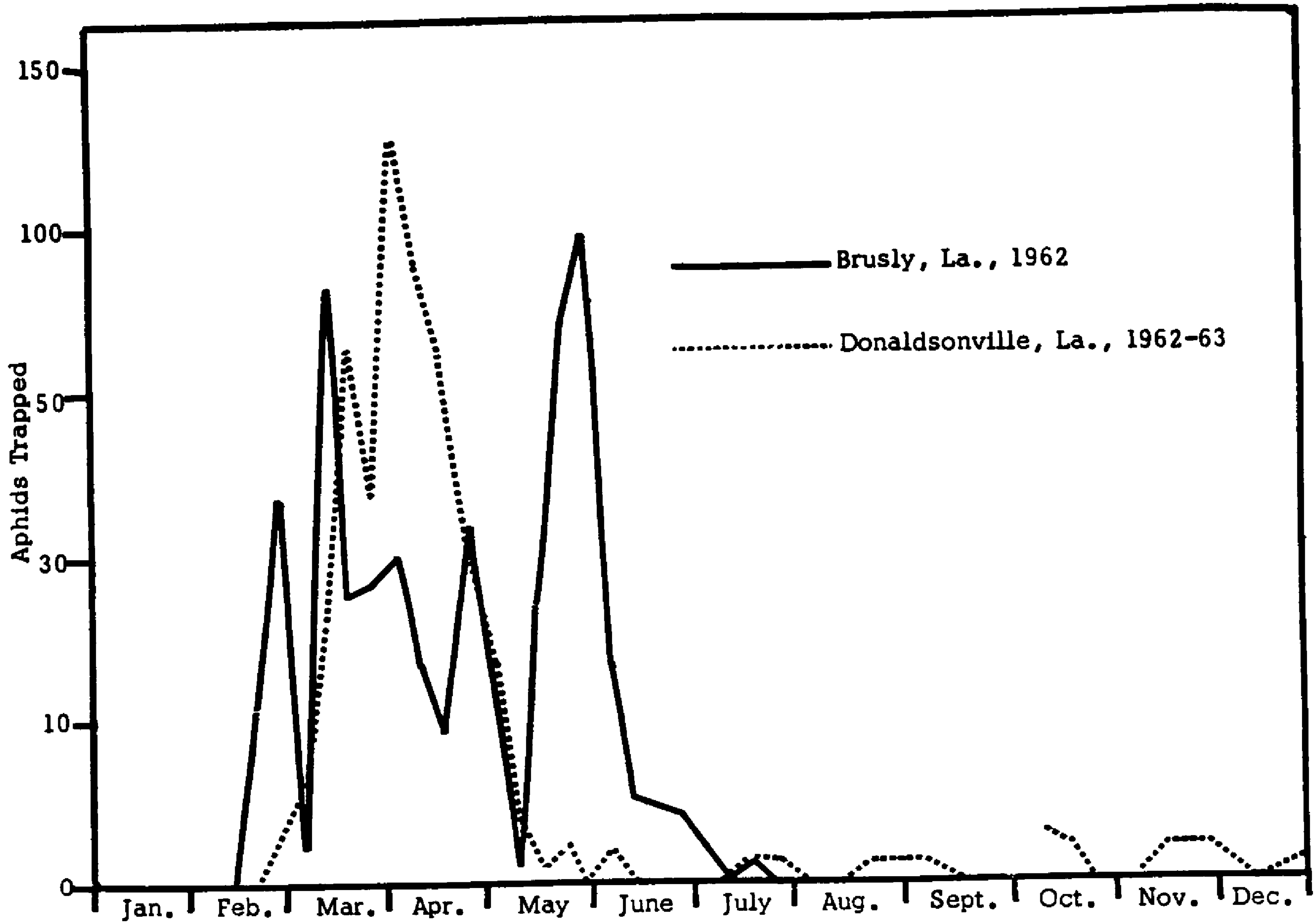


Figure 8. Aphis medicaginis Koch, cowpea aphid.

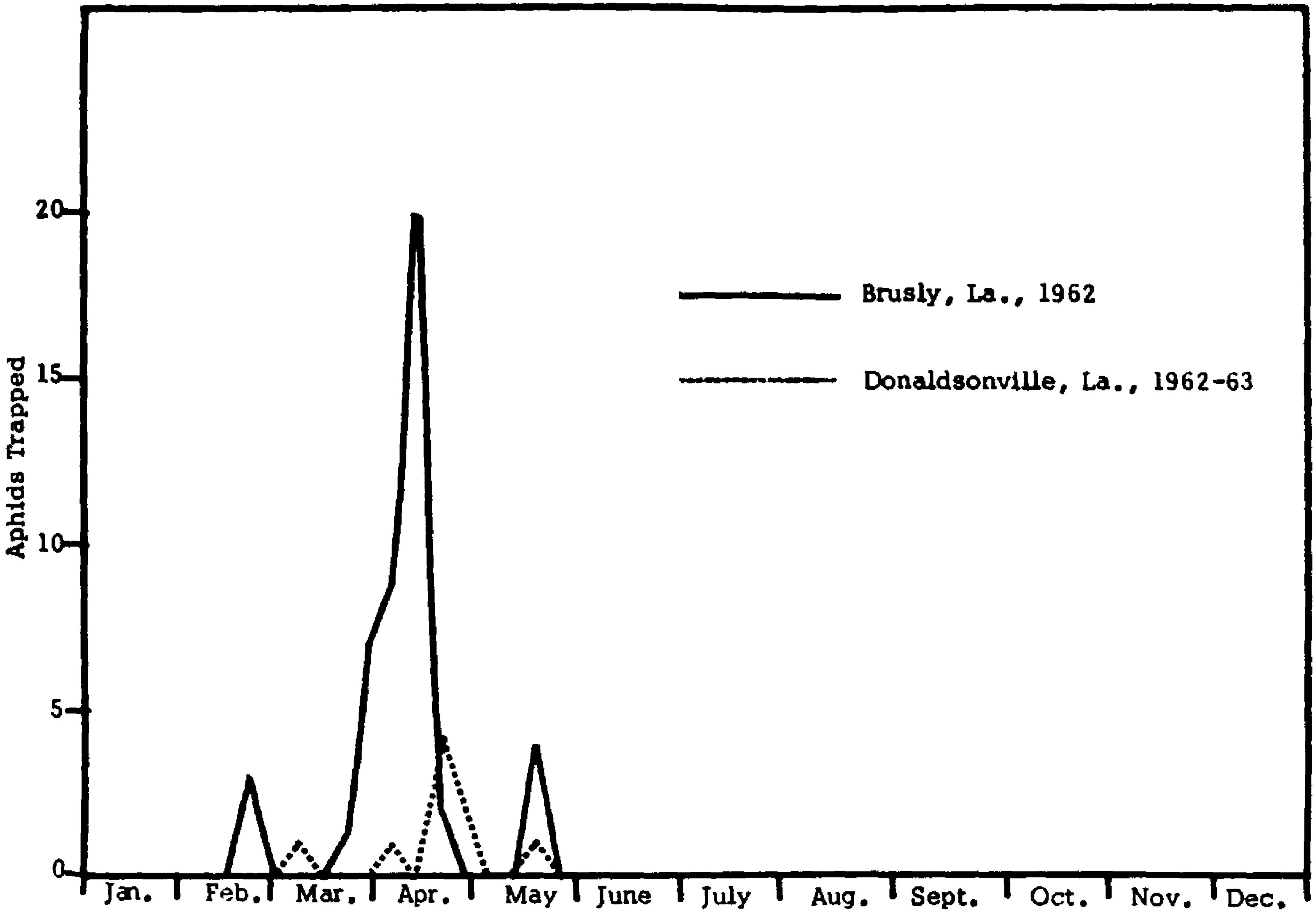


Figure 9. Aphis sambucifoliae Fitch., elder aphid.

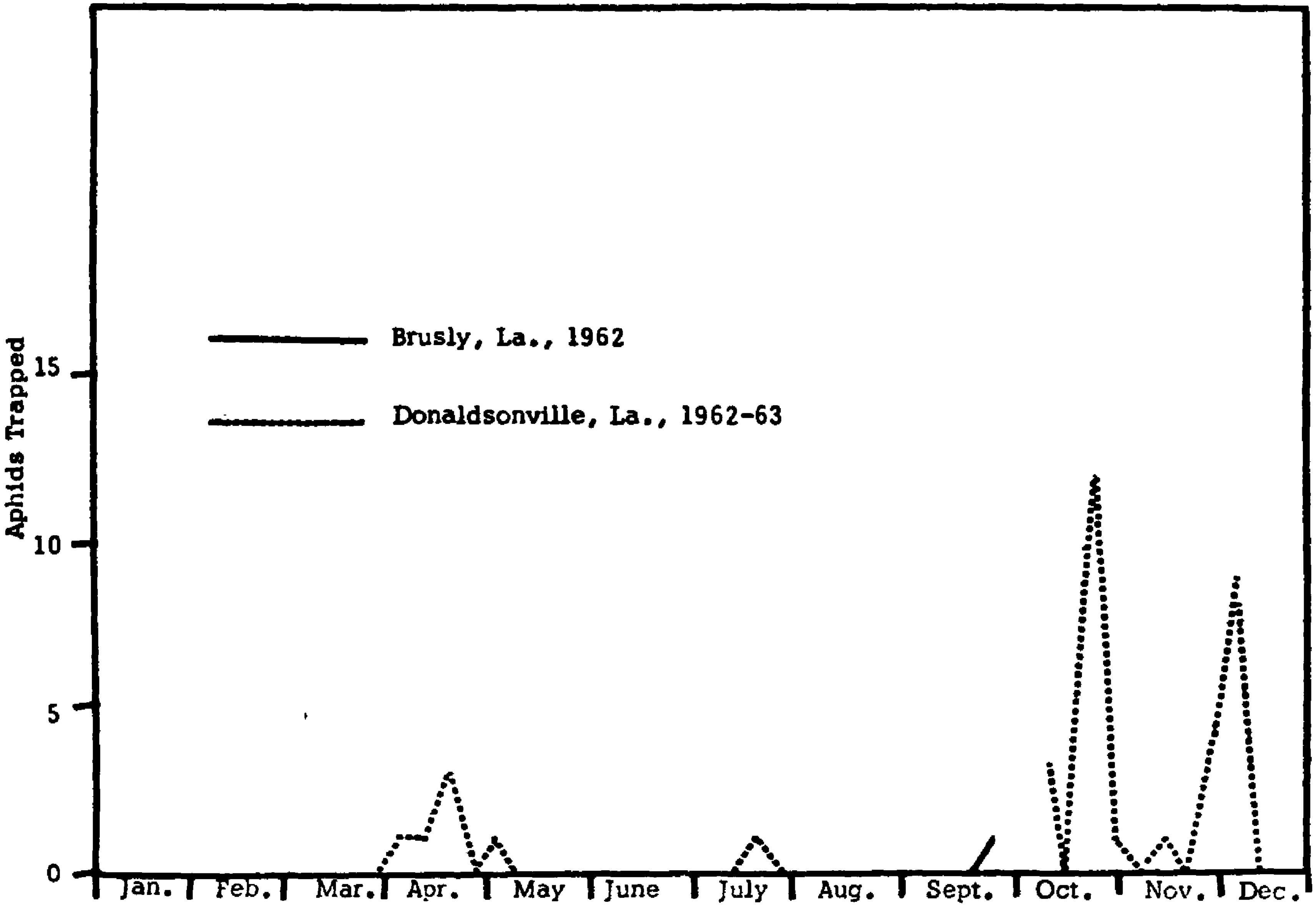


Figure 10. Hysteroneura setariae (Thomas), rusty plum aphid.

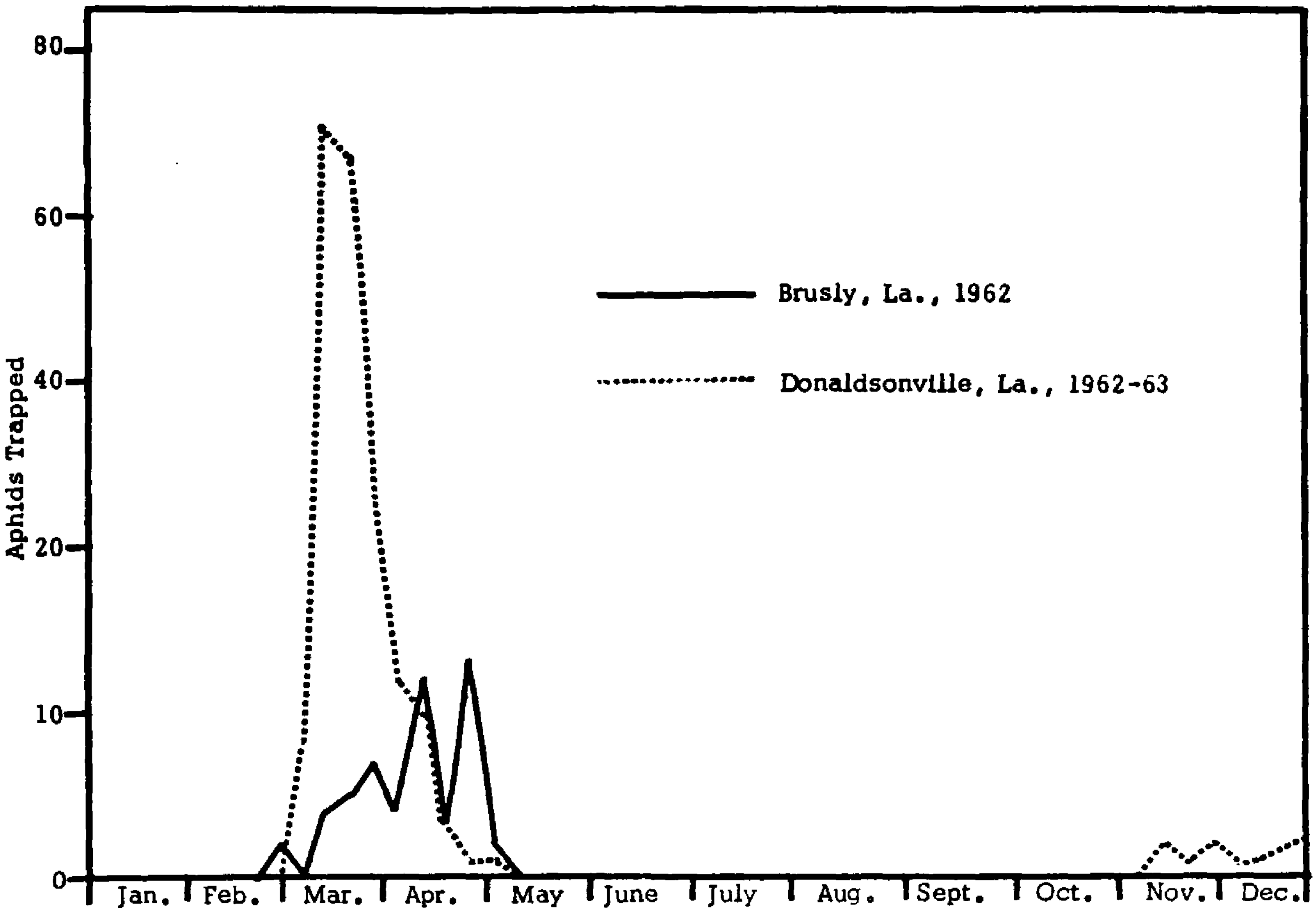


Figure 11. Myzus persicae (Sulzer), green peach aphid.

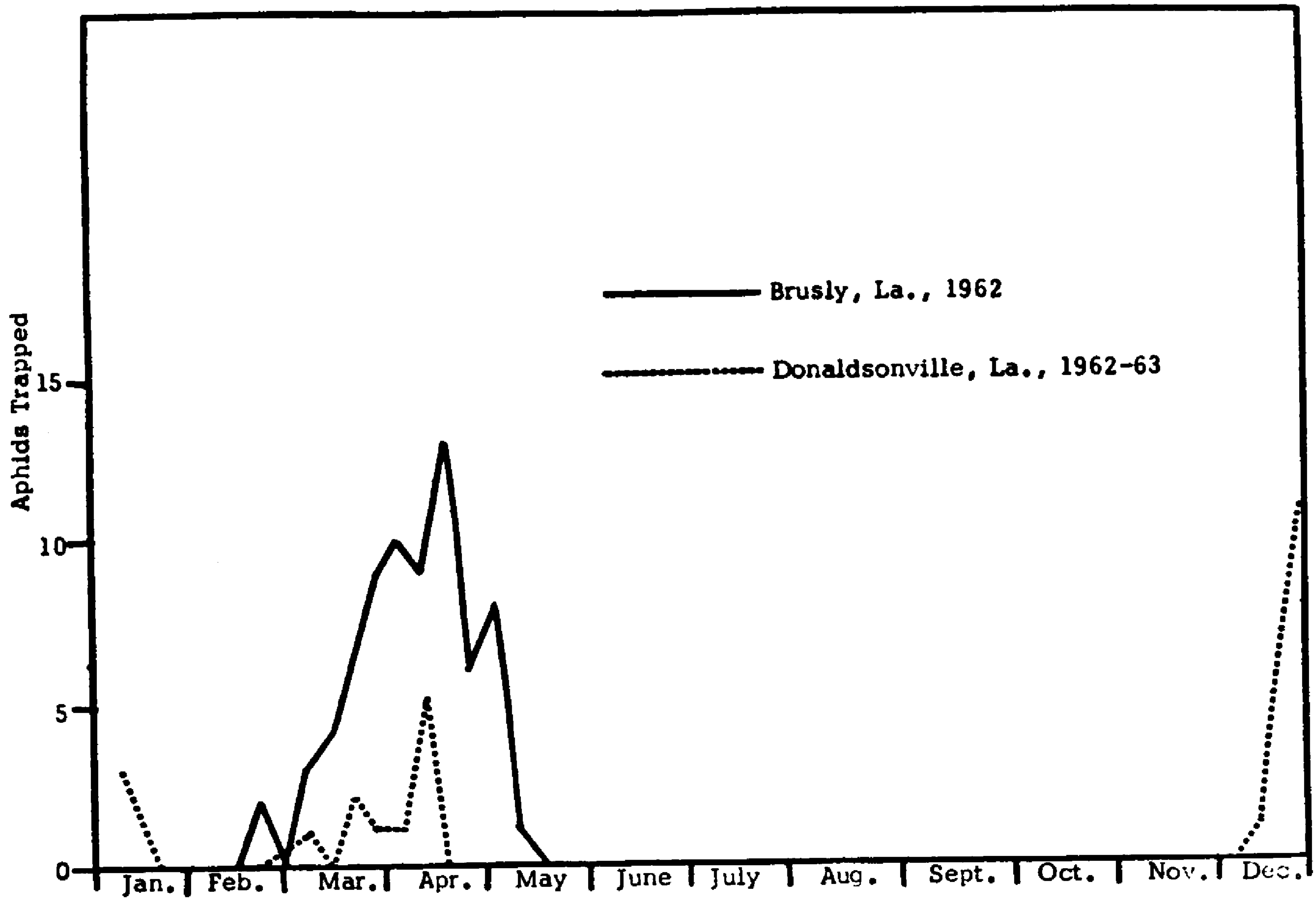


Figure 12. Rhopalosiphum fitchii (Sanderson), apple grain aphid.

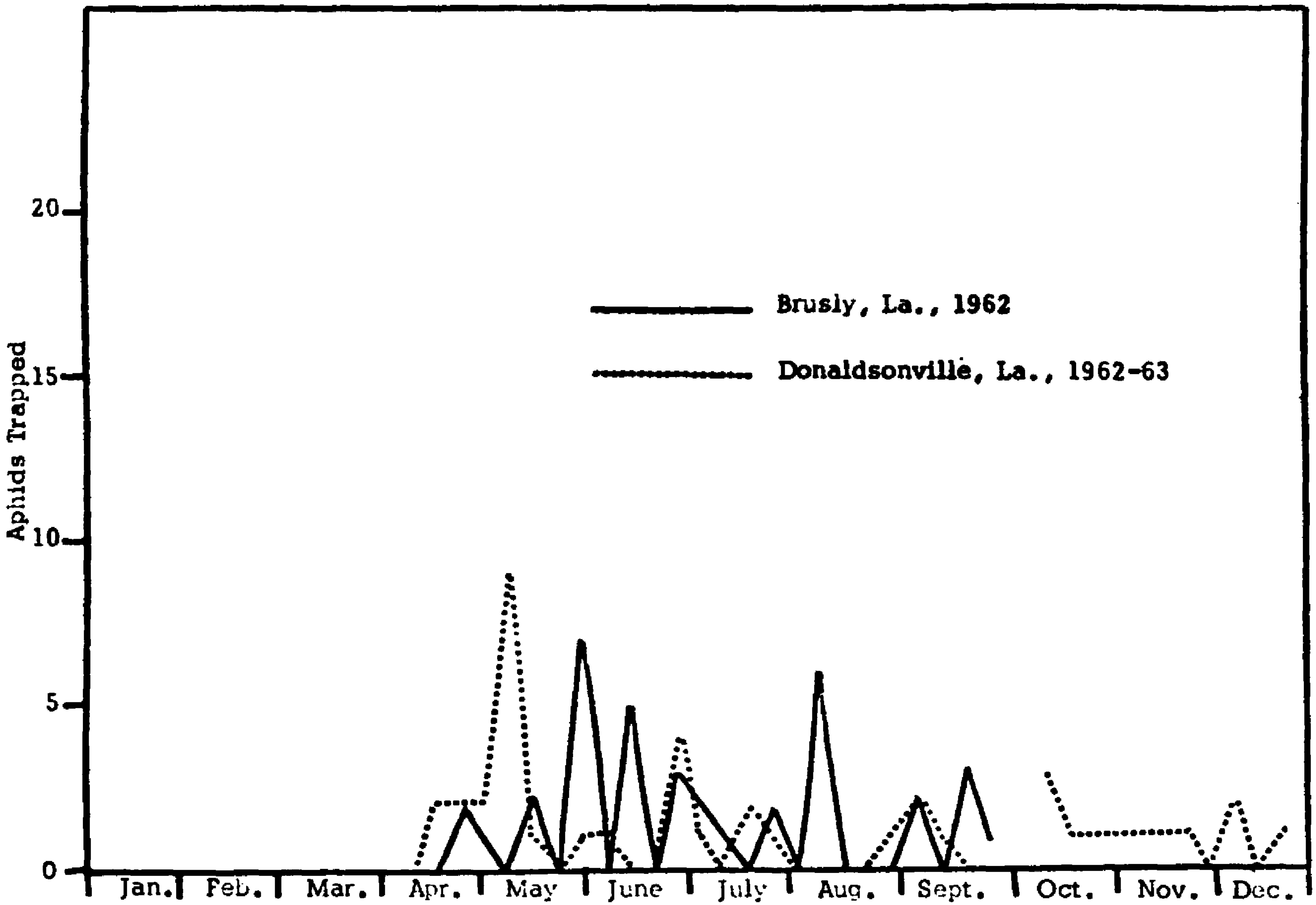


Figure 13. Rhopalosiphum maidis Fitch., corn leaf aphid.

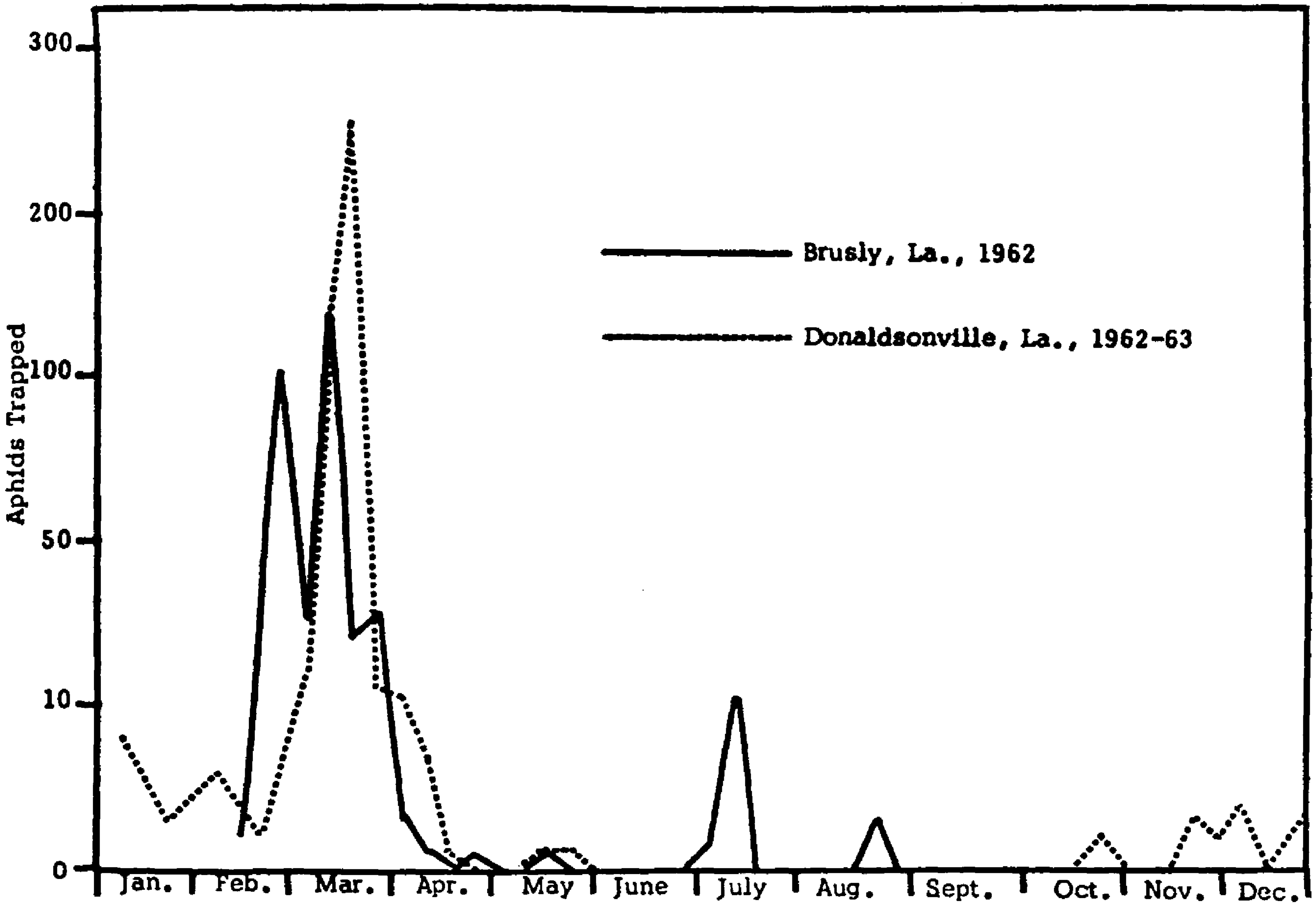


Figure 14. Rhopalosiphum pseudobrassicae (Davis), turnip aphid.

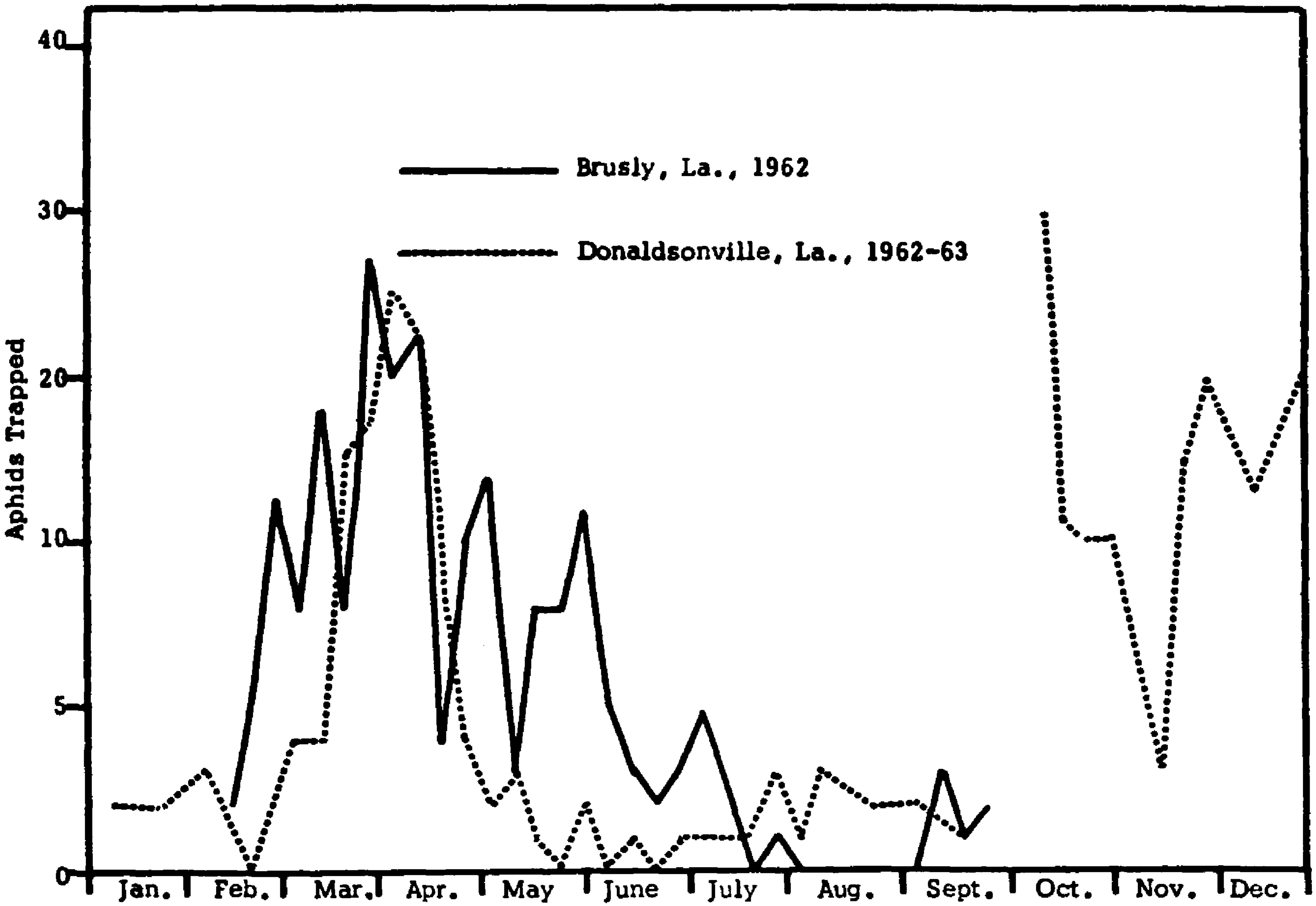


Figure 15. Rhopalosiphum splendens (Theobald), Mediterranean grain aphid.

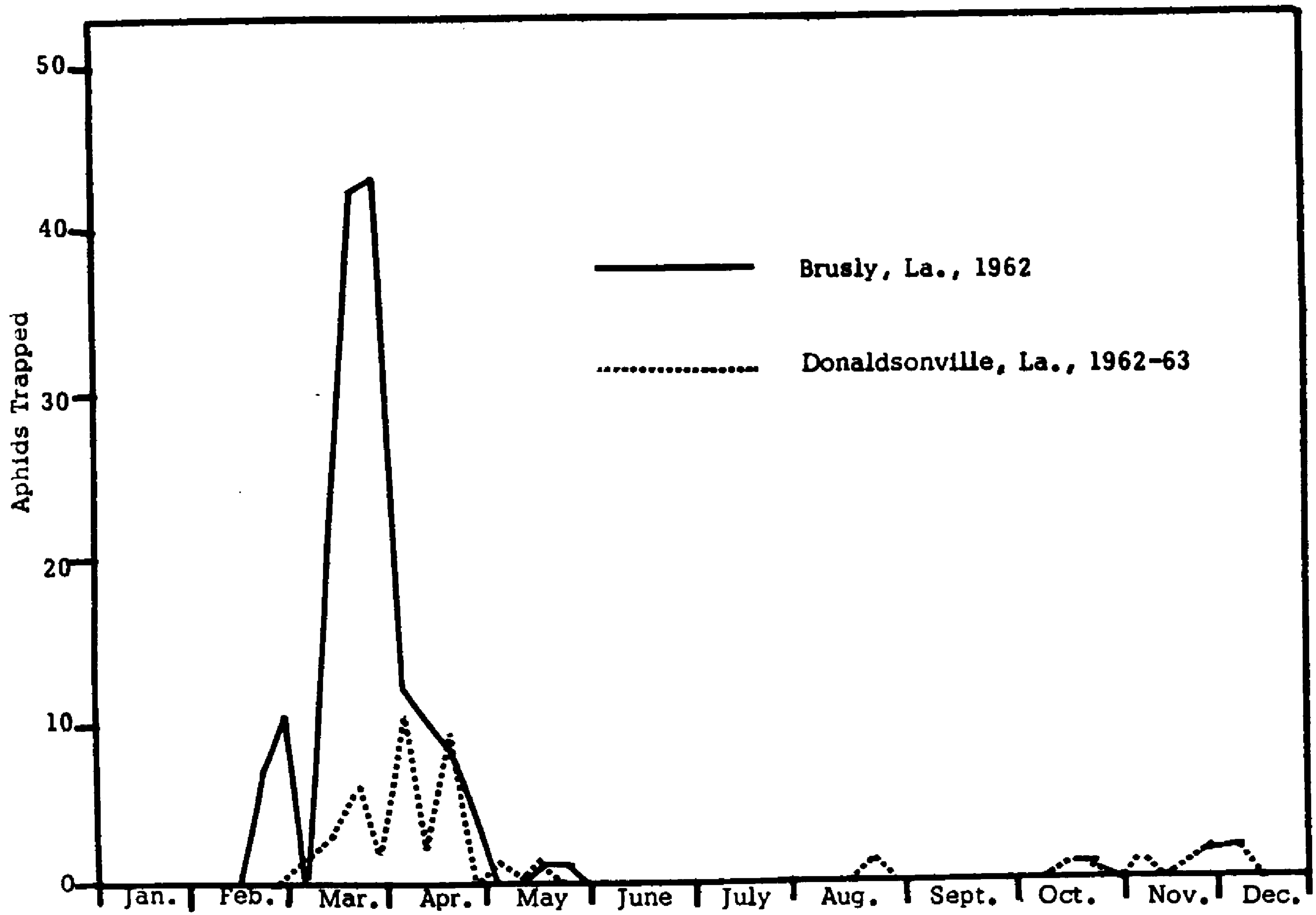


Figure 16. Schizaphis graminum (Rondani), greenbug.

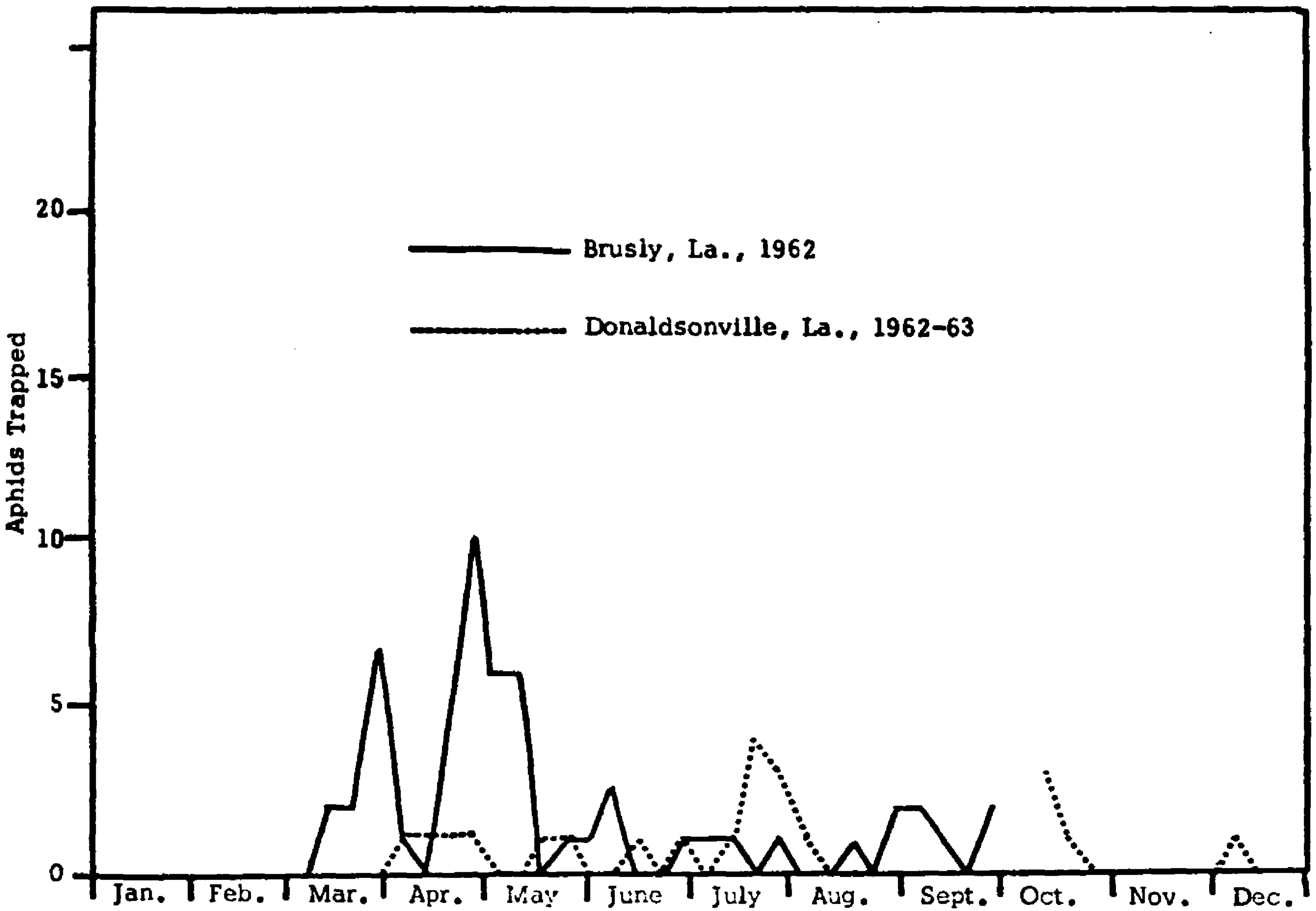


Figure 17. Sipha flava (Forbes), yellow sugarcane aphid.

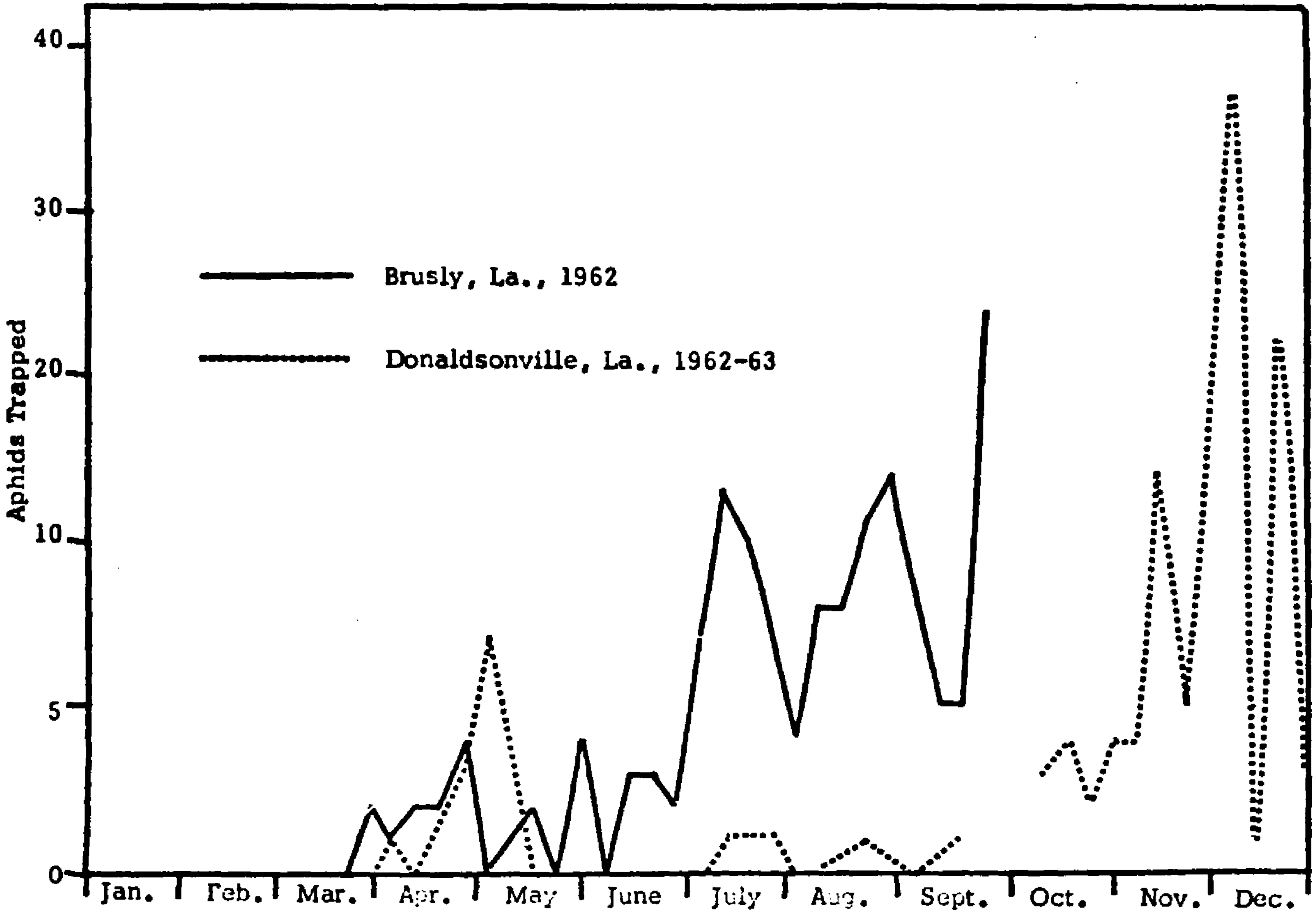


Figure 18. Tetraneura hirsuta (Baker).

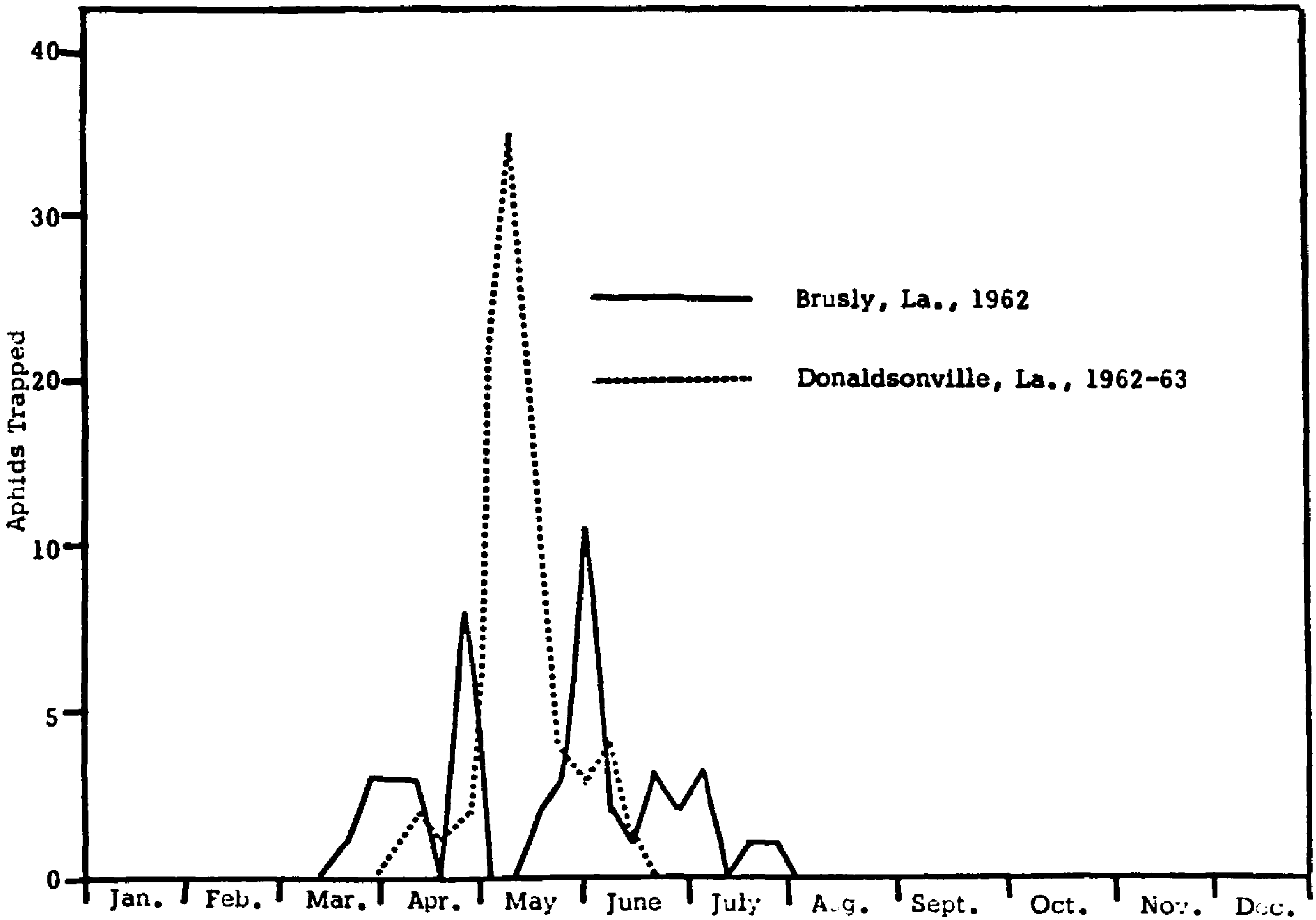


Figure 19. Therioaphis maculata (Buckton), spotted alfalfa aphid.

## Identification of Most Abundant Aphids

The following is a key for identification of the most abundant species of aphids found during these studies. It is based largely on characters described by Dr. H. B. Boudreaux (1946) in his study of Louisiana aphids. The characters mentioned in the key are pictured in Figure 20.

1. Cornicles and cauda reduced; sensoria annular; media of fore wings unbranched; hind wings with one cross vein . . . . . . . . . . . . . . . . . . *Tetraneura hirsuta* (Baker)

    1a. Cornicles and cauda well developed; sensoria circular; media of fore wings branched; hind wings mostly with 2 cross veins . . . . . . . . . . . . . . 2

2. Cornicles equal to or shorter than cauda; cauda knobbed . . . . 3

    2a. Cornicles elongate and definitely longer than cauda; cauda never knobbed. . . . . . . . . . . . . . . . . . . . . 4

3. Antennae 5-segmented; anal plate rounded or only slightly notched posteriorly; head bears long conspicuous setae; abdomen without spots . . . . . . . . . . . *Sipha flava* (Forbes)

    3a. Antennae 6-segmented; anal plate deeply notched posteriorly; head without conspicuous setae; abdomen with small, separated, black spots . . . . . . . . . . . . *Therioaphis maculata* (Buckton)

4. Antennal tubercles definitely projecting beyond vertex. . . . . 5

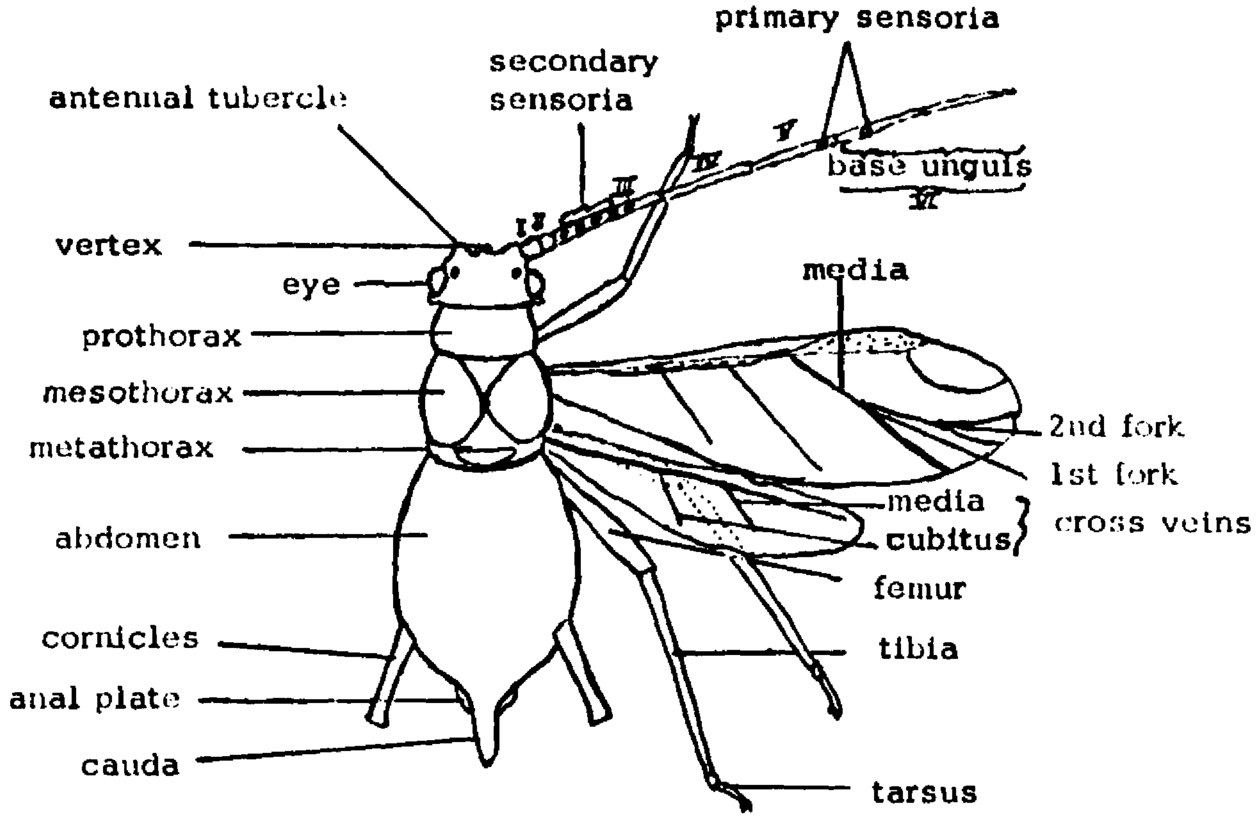


Figure 20. Taxonomic characters used in the key for identification of the most abundant aphids (after H. B. Boudreaux, 1946).

4a. Antennal tubercles projecting only slightly, if at all, beyond vertex . . . . . . . . . . . . . . . . . . 6

5. Antennal tubercles convergent; cornicles slightly swollen; abdomen with dark dorsal patch (sometimes broken into bands) . . . . . . . . . . *Myzus persicae* (Sulzer)

5a. Antennal tubercles divergent; cornicles not swollen and tapering slightly without closed reticulations . . . . . . . . . . *Acyrthosiphon pisum* (Harris)

6. Cornicles swollen, not subcylindrical or tapering. . . . . . . . 7

6a. Cornicles subcylindrical or tapering, not swollen. . . . . . .10

7. Antennae usually 5-segmented. *Rhopalosiphum splendens* (Theobald)

7a. Antennae 6-segmented. . . . . . . . . . . . . . . . . . . .8

8. Unguis 4 to 5 times the length of the base. . . . . . . . . . . . . . . *Rhopalosiphum fitchii* (Sanderson)

8a. Unguis less than 3 times the length of the base. . . . . . 9

9. Cornicles light yellow, slightly swollen apically. . . . . . . . . . *Rhopalosiphum pseudobrassicae* (Davis)

9a. Cornicles dark brown or black, slightly swollen medially. . . . . . . . . . . . *Rhopalosiphum maidis* (Fitch)

10. Fore wings with media branched once. . . . . . . . . . . . . . . .*Schizaphis graminum* (Rondani)

10a. Fore wings with media branched twice. . . . . . . . . . . .11

11. Hind wings without cubitus. . . . *Hysteroneura setariae* (Thomas)

11a. Hind wings with cubitus. . . . . . . . . . . . . . . . . .12

12. Secondary sensoria on antennal segment III scattered indiscriminately over the surface of the segment; cauda conical and pointed or rounded apically, not constricted near the middle. . . . . . . . . . . . *Aphis sambucifoliae* Fitch

12a. Secondary sensoria on antennal segment III arranged more or less in a straight and regular row; cauda conical or elongate, constricted near the middle. . . . . 13

13. Base of antennal segment VI subequal to or longer than V; segment IV with 1 to 3 secondary sensoria. . . . . . . . . . . . . . *Aphis maidiradicis* (Forbes)

13a. Base of antennal segment VI shorter than V; segment IV without secondary sensoria. . . . . . . . . 14

14. Body normally with abdomen black, or with mid-dorsal bands before cornicles; hind tibiae whitish with apex black; diameter of secondary sensoria less than diameter of antennal segment III. . . . . . . . . . *Aphis medicaginis* Koch

14a. Body normally with a lighter color and never with black mid-dorsal bands before cornicles; hind tibiae yellowish with apex brown; diameter of secondary sensoria greater than the diameter of antennal segment III. . . . . . . *Aphis gossypii* Glover

## Incidence of Mosaic

### Seasonal Incidence

Table XXI (page 109) and Figure 23 (page 112) indicate the occurrence of mosaic symptoms on sugarcane in a treated and untreated field plot during 1962 at Brusly, Louisiana. On May 4, when the first inspection was made, 1.2% of the stalks in the check plot showed mosaic symptoms. There was an almost continuous increase in mosaic until late June, when 7.4% of untreated stalks showed symptoms. After this there was a marked masking of symptoms until late summer. Maximum masking of symptoms occurred August 11 when only 4% of the stalks showed mosaic symptoms in the check plot. Mosaic symptoms began to increase again in September and reached 10.6% in the check plot by September 29.

The seasonal incidence of mosaic at Donaldsonville, Louisiana during the 1962-63 growing season was determined periodically by counting the total stalks and those exhibiting symptoms of the disease in small field plots planted on 4 different dates from September 27, 1962 until July 11, 1963 (Table IX, Figure 21). One counting of mosaic was made December 6, 1962 in the earliest planting, but no mosaic was found. However, this is not indicated in Table IX. By this time, cold weather had begun to damage the plants so that it was difficult to detect mosaic symptoms.

The next observation was made April 19, 1963, at which time 11.5% mosaic was found (Table IX, Figure 21). For the next 2 weeks there was little change in incidence of mosaic symptoms. This might be attributed to the fact that new, healthy plants were constantly coming out of the ground.

The greatest increase in the percentage of mosaic symptoms occurred between May 3 and June 7 in the 2 earliest plantings. After this time, the mosaic percentage increased slowly in all of the 4 sugarcane plantings.

Averages of data from Table IX on per cent increase of mosaic for each week indicated that there were no significant differences in rate of appearance of symptoms among the 4 plantings when comparisons of these plantings were confined to the same periods of time. Also, Figure 21 indicates graphically that the rates of increase in mosaic incidence were approximately equal among the different plantings since the lines in the graph are approximately parallel.

## Border Effect

A mosaic count made August 2, 1963, in the large untreated plot at Donaldsonville showed that the average incidence of mosaic in 6 small plots on the ENE side was 31%, while in similar plots on the WSW side of the large plot it was only 14% (Table X). At this time, the incidence of mosaic in the sugarcane adjacent to the untreated plot was 66% on the ENE boundary, and 0% on the WSW boundary.

Table IX. Seasonal incidence of mosaic symptoms in small plots of sugarcane planted with disease-free seed on 4 different dates, Donaldsonville, Louisiana, 1962-63.

| Date of Observation (1963) | | Planted September 27, 1962 Emerged October 11, 1962 | | | | Planted March 1, 1963 Emerged March 29, 1963 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total Plants | No. with Symptoms | Per Cent Mosaic | Per Cent Increase | Total Plants | No. with Symptoms | Per Cent Mosaic | Per Cent Increase |
| April | 19 | 358 | 41 | 11.5 | | 160 | 0 | 0.0 | |
| | 27 | 499 | 58 | 11.6 | | 199 | 4 | 2.0 | |
| May | 3 | 704 | 79 | 11.2 | | 300 | 12 | 4.0 | |
| | 10 | 839 | 119 | 14.2 | 3.0 | 356 | 23 | 6.5 | |
| | 17 | 1109 | 179 | 16.1 | 1.9 | 588 | 35 | 6.0 | |
| | 24 | 1390 | 256 | 18.4 | 2.3 | 857 | 51 | 6.0 | |
| | 31 | 1534 | 310 | 20.2 | 1.8 | 1075 | 75 | 7.0 | 1.0 |
| June | 7 | 1613 | 383 | 23.7 | 3.5 | 1145 | 106 | 9.3 | 2.3 |
| | 13 | 1593 | 380 | 23.9 | .2 | 1185 | 107 | 9.0 | 0.0 |
| | 22 | 1595 | 392 | 24.6 | .7 | 1285 | 130 | 10.1 | .8 |
| | 29 | 1593 | 399 | 25.0 | .4 | 1249 | 146 | 11.7 | 1.6 |
| July | 6 | 1524 | 382 | 25.1 | .1 | 1245 | 151 | 12.1 | .4 |
| | 11 | 1336 | 387 | 29.0 | - [a] | 1021 | 155 | 15.2 | - [a] |
| | 20 | 1277 | 371 | 29.0 | 0.0 | 1021 | 156 | 15.3 | .1 |
| | 27 | 1204 | 356 | 29.6 | .6 | 943 | 150 | 15.9 | .6 |
| August | 3 | 1218 | 366 | 30.0 | .4 | 930 | 163 | 17.5 | 1.6 |
| | 10 | 1210 | 366 | 30.2 | .2 | 921 | 169 | 18.3 | .8 |
| | 22 | 1213 | 376 | 31.0 | .8 | 912 | 177 | 19.4 | 1.1 |
| September | 4 | 1213 | 366 | 30.2 | 0.0 | 912 | 172 | 18.9 | 0.0 |
| | 18 | 1213 | 383 | 31.6 | .6 | 912 | 178 | 19.5 | .1 |

Table IX (cont.)

| Date of Observation (1963) | | Planted April 18, 1963 Emerged April 27, 1963 | | | | Planted July 11, 1963 Emerged July 23, 1963 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total Plants | No. with Symptoms | Per Cent Mosaic | Per Cent Increase | Total Plants | No. with Symptoms | Per Cent Mosaic | Per Cent Increase |
| May | 3 | 119 | 0 | 0.0 | | | | | |
| | 10 | 193 | 0 | 0.0 | | | | | |
| | 17 | 261 | 0 | 0.0 | | | | | |
| | 24 | 342 | 0 | 0.0 | | | | | |
| | 31 | 478 | 0 | 0.0 | | | | | |
| June | 7 | 687 | 11 | 1.6 | | | | | |
| | 13 | 892 | 13 | 1.5 | | | | | |
| | 22 | 1107 | 29 | 2.6 | 1.1 | | | | |
| | 29 | 1130 | 44 | 3.9 | 1.3 | | | | |
| July | 6 | 1106 | 49 | 4.4 | .5 | | | | |
| | 11 | 1105 | 56 | 5.1 | .7 | | | | |
| | 20 | 1099 | 58 | 5.3 | .2 | | | | |
| | 27 | 745 | 55 | 7.4 | -[a] | 368 | 0 | | |
| August | 3 | 742 | 63 | 8.5 | 1.1 | 509 | 0 | | |
| | 10 | 752 | 64 | 8.5 | 0.0 | 498 | 0 | | |
| | 22 | 744 | 72 | 9.7 | 1.2 | 495 | 1 | .2 | |
| September | 4 | 744 | 76 | 10.2 | .5 | 480 | 3 | .6 | .4 |
| | 18 | 744 | 77 | 9.8 | .1 | 464 | 5 | 1.1 | .5 |

[a]Calculation of increase in mosaic deleted for this date since very small suckers were not included among the stalks observed, beginning at this time.

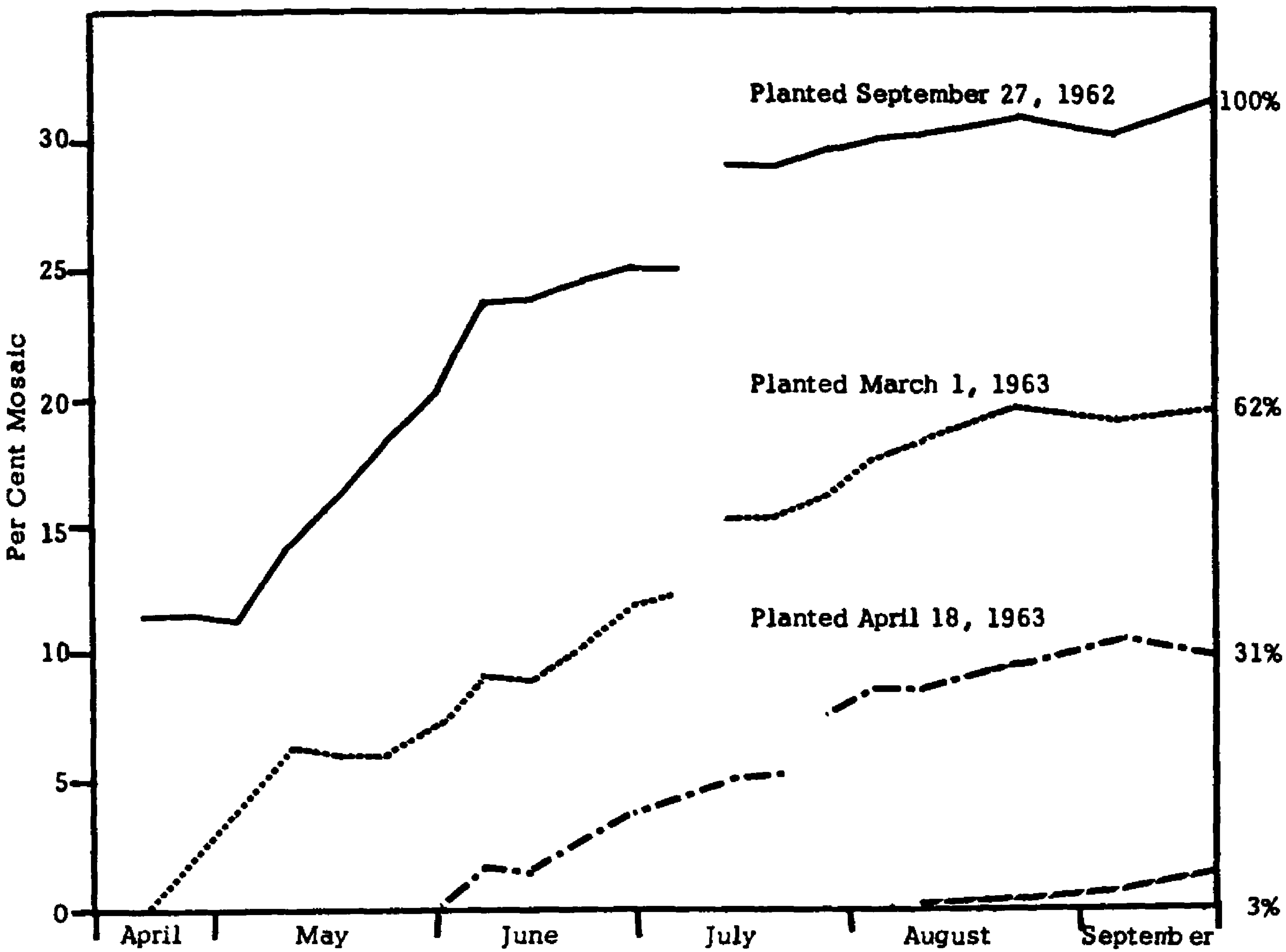


Figure 21. Seasonal incidence of mosaic symptoms in small plots of sugarcane planted on 4 different dates, Donaldsonville, Louisiana, 1963.

Table X. Percentages of 50 stalks showing mosaic symptoms from the untreated plots close to sugardane with and without mosaic infection, Donaldsonville, Louisiana, August 2, 1963.

| Replications | ENE Side of Field, Near Cane with 66% Mosaic | | WSW Side of Field, Near Cane with 0% Mosaic |
|---|---|---|---|
| A | 20 | | 24 |
| B | 38 | | 14 |
| C | 30 | | 18 |
| D | 38 | | 6 |
| E | 34 | | 10 |
| F | 26 | | 12 |
| Mean | 31 | * * | 14 |

Table XI. Percentages of 20 stalks showing mosaic symptoms in the center and near the ditchbank of sugarcane cuts examined during a survey, Louisiana, 1962.

| Parish | Town | Sugarcane Variety | % Mosaic Ditchbank | % Mosaic Center |
|---|---|---|---|---|
| Ascension | Donaldsonville | C.P.52-68 | 0 | 10 |
| | Donaldsonville | N.Co. 310 | 10 | 25 |
| Assumption | Bellerose | N.Co. 310 | 10 | 0 |
| | Napoleonville | C.P.36-105 | 0 | 0 |
| | Paincourtville | C.P.52-68 | 0 | 0 |
| | Supreme | C.P.44-101 | 0 | 0 |
| Iberville | Plaquemine | C.P.52-68 | 0 | 0 |
| | White Castle | N.Co. 310 | 0 | 5 |
| | White Castle | C.P.44-101 | 35 | 5 |
| Lafourche | Raceland | C.P.44-101 | 5 | 5 |
| | Raceland | C.P.44-101 | 20 | 5 |
| | Raceland | C.P.36-105 | 0 | 0 |
| | Raceland | C.P.48-103 | 0 | 0 |
| | Thibodaux | N.Co. 310 | 0 | 0 |
| St. Charles | Hahnville | C.P.48-103 | 15 | 15 |
| | Hahnville | C.P.48-103 | 5 | 0 |
| | Hahnville | N.Co. 310 | 10 | 10 |
| | Kilona | C.P.52-68 | 0 | 0 |
| | Luling | N.Co. 310 | 80 | 60 |
| | Luling | C.P.48-103 | 0 | 0 |
| St. James | Hymel | C.P.52-68 | 0 | 0 |
| | Lutcher | C.P.44-101 | 0 | 5 |
| | Vacherie | C.P.44-101 | 0 | 0 |
| | Vacherie | C.P.52-68 | 15 | 25 |
| St. John Baptist | Edgard | C.P.43-47 | 5 | 0 |
| | Edgard | C.P.43-47 | 0 | 0 |
| | Edgard | N.Co. 310 | 100 | 100 |
| | Johnson | N.Co. 310 | 100 | 75 |
| | Wallace | C.P.44-101 | 5 | 35 |
| | Mean | | 14.3 ns | 13.1 |

A mosaic survey conducted July 24, 1962, in 29 fields of 7 parishes, indicated no significant difference in incidence of disease symptoms between plants close to ditchbanks and plants in the centers of the cuts (Table XI).

## Relationship between Aphids and Mosaic Spread

Table XII shows data and corresponding correlation coefficients between the final incidence of mosaic symptoms observed September 18, 1963 in sugarcane planted on 4 different dates and the numbers of aphids trapped in the same field during the period of sugarcane growth in each of the 4 different plantings. The aphids trapped from August 21 to September 18, 1963 are not included in the computations of these correlation coefficients because an interval of 4 weeks between aphid occurrence and incidence of mosaic symptoms was assumed. The simple correlation coefficient between the final incidence of mosaic in the 4 plantings and the total numbers of flying aphids to which these plantings were exposed was a significant .987.

The simple correlation coefficients between the final incidence of mosaic in the 4 plantings and the total numbers of each of the major species of aphids to which these plantings were exposed varied from .766 to .976. However, these coefficients were significant only for *Aphis gossypii*, *Aphis maidiradicis*, *Aphis medicaginis* and *Schizaphis graminum*.

Table XIII shows the total numbers of aphids and numbers of each major species caught periodically on sticky traps in the large untreated plot at Donaldsonville. It also shows the periodic increases in mosaic incidence observed in the 4 different plantings located nearby. The table is arranged so that periodic increases in mosaic are associated with aphid populations which were trapped during the same length of time but 4 weeks earlier.

Figure 22 shows graphically the closeness of the relationship between weekly increases in mosaic symptoms in the cane planted September 27, 1962 and the total population of aphids which were trapped during equal intervals 4 weeks earlier. However, the first point in each line of this graph represents not weekly increases in mosaic and aphid abundance, but the actual percentage of stalks showing symptoms on that date, and the accumulated total number of aphids to which the cane of this planting was exposed since the time of plant emergence in the fall, respectively.

Table XIV shows simple correlation coefficients, coefficients of determination and partial regression coefficients computed from data in Table XIII. A simple correlation coefficient of .899 was found between numbers of flying aphids periodically taken from sticky traps and the visible increases in mosaic which occurred in the 4 different plantings during equal intervals 4 weeks later. All species of aphids, except <u>Sipha flava</u> and <u>Therioaphis maculata</u>, were highly correlated with disease incidence by simple correlation. The partial regression coefficients indicate that increasing populations of *Myzus persicae*, *Hysteroneura setariae*, *Schizaphis graminum*, *Therioaphis maculata* and *Acyrthosiphon pisum* were associated significantly with increasing amounts of mosaic. *Sipha flava* was not included in the multiple correlation analysis because previous tests have shown that it is not able to transmit sugarcane mosaic.

Table XV presents the coefficients of determination from multiple correlation for successive groups of aphid species with selective deletion of the least correlated species from each successive group. Variation in size of the combined populations of *Hysteroneura setariae* and *Acyrthosiphon pisum* are associated with 86.1% of the observed increases in mosaic symptoms according to this analysis. However, Table XVI shows that the numbers of aphids of different species which were included in the multiple correlation analysis often were highly correlated with each other, since most of these species occurred in relatively high or low abundance at about the same time.

Table XII. Data and corresponding correlation coefficients between the incidence of sugarcane mosaic symptoms observed September 18, 1963 in small plots of sugarcane planted on 4 different dates, and the numbers of aphids of different species trapped in the same field during periods of plant growth after emergence in the different plantings until August 21, 1963, Donaldsonville, Louisiana.

| | 1st Planting | 2nd Planting | 3rd Planting | 4th Planting | Simple Correlation Coefficients (r) | |
|---|---|---|---|---|---|---|
| Date of planting | 9/27/62 | 3/1/63 | 4/18/63 | 7/11/63 | | |
| Date of fall emergence | 10/11/62 | | | | | |
| Date of killing frost | 12/27/63 | | | | | |
| Date of spring or summer emergence | 2/28/63 | 3/29/63 | 4/27/63 | 7/23/63 | | |
| Per cent mosaic[a] | 31.6 | 19.5 | 9.8 | 1.1 | | |
| Total aphids | 2882 | 1597 | 397 | 24 | .987 | * |
| Acyrthosiphon pisum | 493 | 486 | 64 | 0 | .910 | ns |
| Aphis gossypii | 194 | 104 | 13 | 1 | .976 | * |
| Aphis maidiradicis | 248 | 221 | 60 | 0 | .951 | * |
| Aphis medicaginis | 470 | 332 | 27 | 2 | .961 | * |
| Hysteroneura setariae | 34 | 7 | 2 | 0 | .911 | ns |
| Myzus persicae | 214 | 30 | 1 | 0 | .937 | ns |
| Rhopalosiphum fitchii | 22 | 6 | 0 | 0 | .927 | ns |
| Rhopalosiphum maidis | 35 | 26 | 22 | 1 | .932 | ns |
| Rhopalosiphum pseudobrassicae | 458 | 23 | 2 | 0 | .844 | ns |
| Rhopalosiphum splendens | 246 | 81 | 22 | 9 | .942 | ns |
| Schizaphis graminum | 44 | 24 | 3 | 1 | .972 | * |
| Sipha flava | 19 | 17 | 13 | 4 | .925 | ns |
| Tetraneura hirsuta | 134 | 23 | 17 | 2 | .893 | ns |
| Therioaphis maculata | 90 | 90 | 84 | 0 | .766 | ns |

[a]Per cent of stalks with visible symptoms of mosaic at time of last observation, September 18, 1963.

Table XIII. Periodic increases in incidence of mosaic symptoms and numbers of aphids of different species trapped 4 weeks prior to the indicated increase in mosaic, Donaldsonville, Louisiana, 1962-63

| Interval During Which Mosaic Increased | Increase in % Mosaic in Plots Planted on 4 Different Dates | | | | Interval During Which Aphids Were Trapped | A. pisum | A. gossypii | A. maidiradicis | A. medicaginis | H. setariae | M. persicae | R. fitchii | R. maidis | R. splendens | R. pseudobrassicae | R. graminum | S. flava | T. hirsuta | T. maculata | Miscellaneous | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9/27/62 | 3/1/63 | 4/18/63 | 7/11/63 | | | | | | | | | | | | | | | | | |
| 10/11/62-5/3/63 | 11.2 | | | | 10/11/62-4/5/63[a] | 11 | 104 | 65 | 264 | 28 | 197 | 17 | 9 | 190 | 448 | 30 | 3 | 112 | 1 | 86 | 1565 |
| 3/29/63 -5/24/63 | | 6.0 | | | 3/29/63 -4/27/63 | 422 | 91 | 161 | 305 | 5 | 29 | 6 | 4 | 59 | 21 | 21 | 4 | 6 | 6 | 60 | 1200 |
| 4/27/63 -6/13/63 | | | 1.5 | | 4/27/63 -5/17/63 | 61 | 8 | 53 | 20 | 1 | 1 | 0 | 12 | 6 | 1 | 2 | 1 | 13 | 72 | 34 | 285 |
| 7/23/63 -8/22/63 | | | | .2 | 7/23/63 -7/27/63 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 3 | 1 | 0 | 1 | 11 |
| 5/3/63 -5/10/63 | 3.0 | | | | 4/5/63 -4/11/63 | 30 | 37 | 13 | 87 | 1 | 12 | 5 | 0 | 22 | 7 | 2 | 1 | 0 | 2 | 8 | 227 |
| 5/10/63 -5/17/63 | 1.9 | | | | 4/11/63 -4/19/63 | 57 | 25 | 47 | 60 | 3 | 3 | 0 | 2 | 8 | 1 | 9 | 1 | 2 | 1 | 15 | 234 |
| 5/17/63 -5/24/63 | 2.3 | | | | 4/19/63 -4/27/63 | 331 | 15 | 63 | 32 | 0 | 1 | 0 | 2 | 4 | 0 | 0 | 1 | 3 | 2 | 5 | 459 |
| 5/24/63 -5/31/63 | 1.8 | 1.0 | | | 4/27/63 -5/3/63 | 52 | 5 | 31 | 16 | 1 | 1 | 0 | 2 | 2 | 0 | 1 | 0 | 7 | 23 | 11 | 152 |
| 5/31/63 -6/7/63 | 3.5 | 2.3 | | | 5/3/63 -5/10/63 | 8 | 2 | 11 | 3 | 0 | 0 | 0 | 9 | 3 | 0 | 0 | 0 | 4 | 35 | 7 | 82 |
| 6/7/63 -6/13/63 | .2 | 0.0 | | | 5/10/63 -5/17/63 | 1 | 1 | 11 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 14 | 16 | 51 |
| 6/13/63 -6/22/63 | .7 | .8 | 1.1 | | 5/17/63 -5/24/63 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 4 | 7 | 18 |
| 6/22/63 -6/29/63 | .4 | 1.6 | 1.3 | | 5/24/63 -5/31/63 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 3 | 9 | 22 |
| 6/29/63 -7/6/63 | .1 | .4 | .5 | | 5/31/63 -6/7/63 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 9 |
| 7/6/63 -7/11/63 | | | .7 | | 6/7/63 -6/14/63 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | C | 0 | 1 | 0 | 1 | 9 | 13 |
| 7/11/63 -7/20/63 | 0.0 | .1 | .2 | | 6/14/63 -6/22/63 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| 7/20/63 -7/27/63 | .6 | .6 | | | 6/22/63 -6/28/63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 7 |
| 7/27/63 -8/3/63 | .4 | 1.6 | 1.1 | | 6/28/63 -7/6/63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 8/3/63 -8/10/63 | .2 | .8 | 0.0 | | 7/6/63 -7/12/63 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 4 |
| 8/10/63 -8/22/63 | .8 | 1.1 | 1.2 | | 7/12/63 -7/27/63 | C | 2 | 0 | 2 | 1 | 0 | 0 | 3 | 4 | 0 | 0 | 7 | 2 | 0 | 1 | 22 |
| 8/22/63 -9/4/63 | .0 | 0.0 | .5 | .4 | 7/27/63 -8/9/63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 2 | 7 |
| 9/4/63 -9/18/63 | .6 | .1 | .1 | .5 | 8/9/63 -8/21/63 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 6 |

[a]The numbers of aphids which were trapped from 12/28/1962 to 2/28/1963 are not included here since aerial parts of plants were dead due to cold weather during this time.

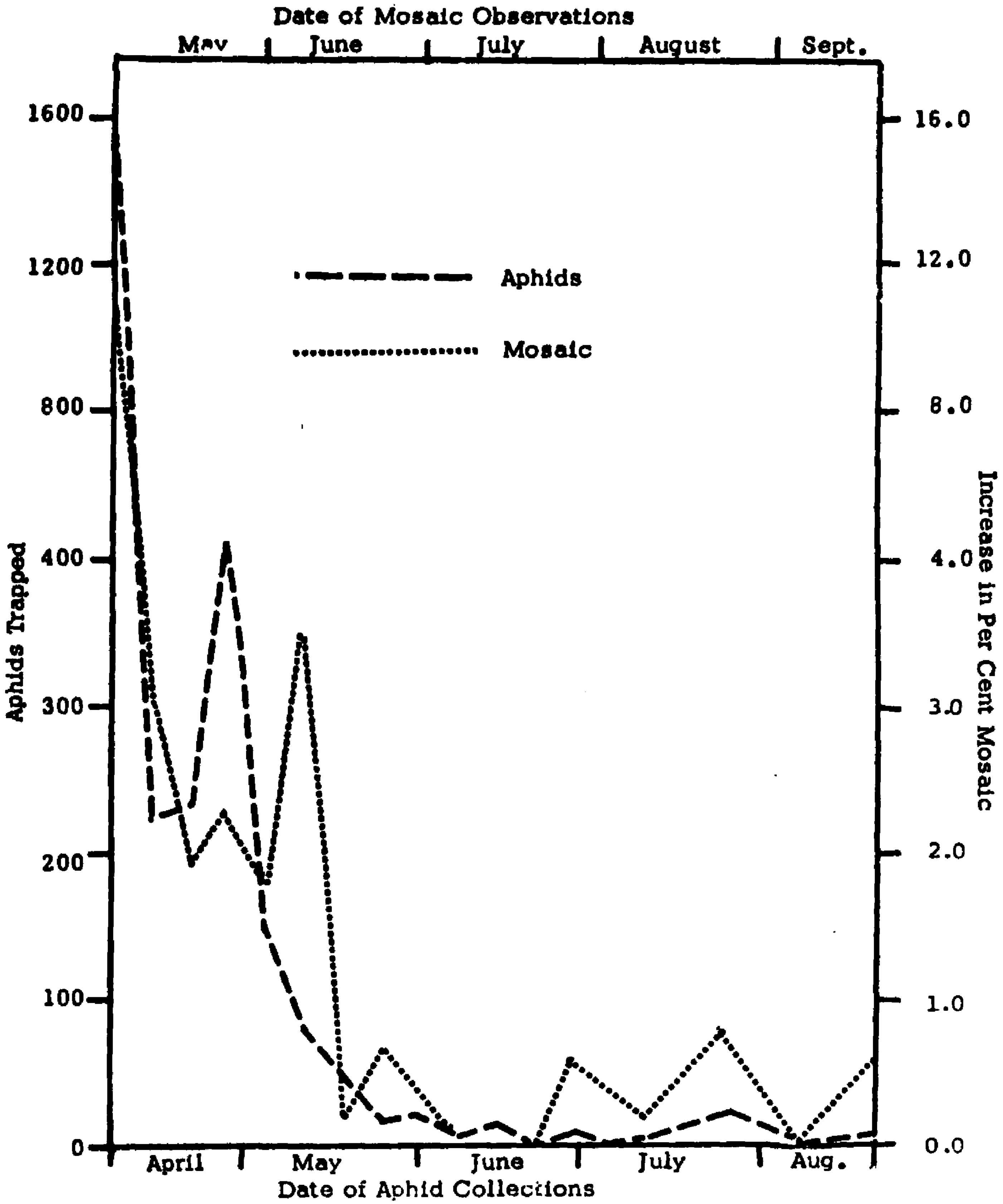


Figure 22. Relationship between weekly increases of mosaic in the planting of September 27, 1962 and aphids trapped during the same interval 4 weeks earlier.

Table XIV. Statistical coefficients computed from periodic changes in the percentages of plants with mosaic symptoms and the numbers of each aphid species trapped during equal periods 4 weeks earlier, Donaldsonville, Louisiana, 1962-63.

| Aphid Species | Simple Correlation Coefficient (r) | Coefficient of Determination ($R^2$) | Partial Regression Coefficients (b) |
|---|---|---|---|
| Acyrthosiphon pisum | .404 * | .164 | .097 ** |
| Aphis gossypii | .909 ** | .825 | - .130** |
| Aphis maidiradicis | .672 ** | .452 | - .344 ** |
| Aphis medicaginis | .866 ** | .750 | - .267 ** |
| Hysteroneura setariae | .878 ** | .771 | 5.251 ** |
| Myzus persicae | .868 ** | .754 | 5.501 ** |
| Rhopalosiphum fitchii | .909 ** | .826 | -5.387 ** |
| Rhopalosiphum maidis | .581 ** | .338 | - .436 ** |
| Rhopalosiphum pseudobrassicae | .827 ** | .684 | -1.945 ** |
| Rhopalosiphum splendens | .910 ** | .829 | - .076 ns |
| Schizaphis graminum | .891 ** | .794 | .556 ** |
| Sipha flava | .253 ns | .064 | --- |
| Tetraneura hirsuta | .838 ** | .702 | -1.351 ** |
| Therioaphis maculata | .138 ns | .019 | .446 ** |
| Miscellaneous | .875 ** | .767 | --- |
| Total | .899 ** | .809 | --- |

Table XV. Coefficients of determination ($R^2$) from multiple correlation analysis of periodic changes in mosaic incidence with abundance of different groups of aphid species, Donaldsonville, Louisiana, 1962-63.

| Aphid Species | .861 | .879 | .889 | .914 | .936 | .936 | .946 | .958 | .967 | .970 | .974 | .976 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hysteroneura setariae | X | X | X | X | X | X | X | X | X | X | X | X |
| Acyrthosiphon pisum | X | X | X | X | X | X | X | X | X | X | X | X |
| Therioaphis maculata | | X | X | X | X | X | X | X | X | X | X | X |
| Tetraneura hirsuta | | | X | X | X | X | X | X | X | X | X | X |
| Aphis maidiradicis | | | | X | X | X | X | X | X | X | X | X |
| Myzus persicae | | | | | X | X | X | X | X | X | X | X |
| Rhopalosiphum fitchii | | | | | | X | X | X | X | X | X | X |
| Rhopalosiphum pseudobrassicae | | | | | | | X | X | X | X | X | X |
| Aphis medicaginis | | | | | | | | X | X | X | X | X |
| Rhopalosiphum maidis | | | | | | | | | X | X | X | X |
| Schizaphis graminum | | | | | | | | | | X | X | X |
| Aphis gossypii | | | | | | | | | | | X | X |
| Rhopalosiphum splendens | | | | | | | | | | | | X |

Table XVI. Simple correlation coefficients between species of aphids most frequently caught on sticky traps, Donaldsonville, Louisiana, 1962-63.

| Aphid Species | A. pisum | A. gossypii | A. maidiradicis | A. medicaginis | H. setariae | M. persicae | R. fitchii | R. maidis | R. pseudobrassicae | R. splendens | S. graminum | T. hirsuta | T. maculata |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A. pisum | 1.000 | .559 | .876 | .625 | .121 | .945 | .231 | .183 | .126 | .214 | .435 | .409 | -.100 |
| A. gossypii | .559 | 1.000 | .808 | .988 | .824 | .807 | .909 | .387 | .739 | .886 | .961 | .734 | -.335 |
| A. maidiradicis | .876 | .808 | 1.000 | .855 | .452 | .407 | .525 | .426 | .324 | .524 | .747 | .370 | .274 |
| A. medicaginis | .625 | .988 | .855 | 1.000 | .753 | .733 | .853 | .359 | .656 | .828 | .946 | .652 | .454 |
| H. setariae | .121 | .824 | .452 | .753 | 1.000 | .993 | .945 | .435 | .984 | .985 | .893 | .980 | -.280 |
| M. persicae | .945 | .807 | .407 | .733 | .993 | 1.000 | .959 | .404 | .994 | .987 | .866 | .982 | -.526 |
| R. fitchii | .231 | .909 | .525 | .853 | .945 | .959 | 1.000 | .376 | .925 | .982 | .906 | .907 | -.623 |
| R. maidis | .183 | .387 | .426 | .359 | .435 | .404 | .376 | 1.000 | .396 | .423 | .404 | .489 | .737 |
| R. pseudobrassicae | .126 | .739 | .324 | .656 | .984 | .994 | .925 | .396 | 1.000 | .964 | .816 | .989 | -.542 |
| R. splendens | .214 | .886 | .524 | .828 | .985 | .987 | .982 | .423 | .964 | 1.000 | .924 | .954 | -.400 |
| S. graminum | .435 | .961 | .747 | .946 | .893 | .866 | .906 | .404 | .816 | .924 | 1.000 | .813 | -.400 |
| T. hirsutu | .409 | .734 | .370 | .652 | .980 | .982 | .907 | .489 | .989 | .954 | .813 | 1.000 | .746 |
| T. maculata | -.100 | -.335 | .274 | .454 | -.280 | -.526 | -.623 | .737 | -.542 | -.400 | -.400 | .746 | 1.000 |

## Control of Aphids and Mosaic

### Insecticides

At Brusly, Louisiana applications of Di-Syston granules made February 24 and March 20, 1962 at rates of 2.8 and 2.6 pounds per acre of active material, respectively, failed to reduce the aphid population caught on traps from March 2 to May 4, 1962. During this period 1,420 aphids were trapped in the check and 1,804 in the treated plot. At Donaldsonville, Louisiana, Di-Syston was applied February 15 and March 17, 1963, but demeton applications began March 15, 1963 and were also made during fall, 1962. For this reason, the effect of Di-Syston cannot be separated from that of demeton at Donaldsonville.

Table XVII shows that 16.9% and 20.5% fewer total aphids were trapped in the treated than in the check plots at Brusly and Donaldsonville, respectively. These reductions were significant at the 5% level. Significant reductions of populations of *Rhopalosiphum splendens* were obtained at Brusly, and significant reductions of *Aphis gossypii*, *Aphis maidiradicis*, *Aphis medicaginis* and *Therioaphis maculata* were obtained at Donaldsonville. *Tetraneura hirsuta* populations were significantly reduced in treated plots during insecticide applications of both locations. With other species differences between treated and check plots were not significant.

Table XVIII shows the numbers of aphids caught on sugarcane plants during periods of demeton applications in demeton-treated and untreated plots, at Brusly and Donaldsonville. Significantly fewer adults and nymphs were found in the treated than in the untreated plot at Donaldsonville. A smaller non-significant reduction occurred at Brusly, possibly due to the fact that intervals between insecticide applications and observations frequently were longer.

Table XIX indicates that more aphids usually were found on plants in the check plots than in the treated plots at both locations. Fewer aphids were found on plants in the treated plots even 12-26 days after insecticide applications.

Table XX indicates that with most species more aphids were found on the plants in the untreated than in the treated plots.

Table XXI and Figure 23 show that after May 4, 1962 the weekly average mosaic incidence always was less in the treated than in the untreated plot at Brusly. This difference, averaged for all dates, is significant at the 1% level. Masking of mosaic symptoms appeared to occur during summer in both check and treated plots. At the last observation, September 29, 1962, there was 10.6% mosaic in the check plot and 4.4% in the center of the treated plot. This indicates a 58% reduction of mosaic in the center of the treated plot.

At Donaldsonville on November 1, 1962, 4 weeks after the sugarcane had emerged from the ground, the incidence of mosaic was 1.5% in the check plot and 1.7% in the treated plot. Three weeks later, mosaic had increased to 3.3% in the check and 1.8% in the treated plot. These random counts were made before subplots were established and therefore are not included in Table XXII.

Table XXII and Figure 24 show that the weekly average mosaic incidence was less in the center of the treated than in the untreated plot at Donaldsonville from April 11 to June 28, 1963. This difference averaged for all dates is significant at the 1% level. The final count on June 28, 1963 showed 18.4% mosaic in the center of the check plot and 10.8% in the center of the treated plot. This indicates a 41% reduction of mosaic in the center of the treated plot.

Table XXIII shows the percentages of mosaic at bi-weekly intervals on different rows from the SSE periphery to the center of the treated and untreated plot at Donaldsonville. The average mosaic incidence was less in the SSE half of the treated plot than in the SSE half of the untreated plot from April 11 to June 21, 1963. This difference averaged for all dates is significant at the 5% level. The final mosaic count showed 25.8% mosaic in the untreated plot and 14.7% in the treated plot, or a 45% reduction of mosaic in the treated plot.

Milk and Casein

Table XXIV shows that a total of 24 aphids of several different species were caught on plants in the milk-treated plots, and 31 on plants in the untreated plots. Collections were made just before each application of milk from July 28, 1962 to June 14, 1963. This difference was not statistically significant.

Table XXV and Figure 25 indicate that at Brusly there was very little spread of mosaic during summer and fall of 1962 in sugarcane which was planted July 18 and emerged July 28, 1962. Symptoms first appeared in the check plot September 15, but did not exceed 1% until April 19, 1963, when 7.1% mosaic was found. A higher percentage of mosaic always was observed in the check plots than in the milk-treated plots from April 19 to June 14, 1963. These differences proved to be highly significant statistically. At the final inspection on June 14, 1963, 23.3% mosaic was observed in the check plot and 13.8% in the milk-treated plots. This amounts to a 41% reduction of mosaic in milk-treated plots.

Table XXV indicates also that fewer stalks were found at each observation in the milk-treated than in the check plots. Phytotoxicity from treatment with whole milk appeared in the form of small reddish spots and larger yellowish spots on the leaves of the treated plants. Diluting whole milk with water reduced phytotoxicity on new leaves, but did not eliminate it completely. Milk-treated sugarcane plants, almost from the beginning of applications, were somewhat smaller than untreated plants. Greenhouse tests indicated that skim milk was less phytotoxic than whole milk. For this reason skim milk was used instead of whole milk at Brusly and Donaldsonville, beginning April 5, 1963.

Table XXVI and Figure 26 show that at Donaldsonville the incidence of mosaic was higher in plots treated with skim milk and casein than in check plots which were free of mosaic May 31, 1963. Three weeks later, as new plants came out and as the applications with skim milk and casein continued, more mosaic was found in the check plots than in the milk and casein-treated plots. On May 31 mosaic incidence was 0%, 3.9%, and 3.0% for the check plots, the milk-treated and the casein-treated plots, respectively. At the last count, July 20, incidence of mosaic was 12.6%, 9.5% and 11.5% for the same plots, respectively. If only the observations after June 22 are considered, the differences in mosaic incidence among treatments are significant at the 1% level. These differences suggest a reduction of 25% in mosaic incidence in the skim milk plots and 11% in the casein plots.

Only a small number of aphids were caught on the plants in these small field plots during the time of the weekly observations from May 31 to July 20, 1963. These included 2 winged adults and 1 nymph in the check plots, 4 winged adults in the milk plots, and 3 winged adults and 2 nymphs in the casein plots. These specimens belonged to the species *Rhopalosiphum maidis*, *Hysteroneura setariae*, and *Sipha flava*.

Skim milk was slightly phytotoxic at Donaldsonville, but less so than diluted whole milk had been at Brusly. Casein showed some phytotoxicity, but less than skim milk.

Table XVII. Numbers of aphids trapped during periods of demeton applications in demeton-treated and untreated plots of field experiments at Brusly and Donaldsonville, Louisiana, 1962-63.

| Observation Number | Total Aphids | | | | Acyrthosiphon pisum | | | | Aphis gossypii | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | |
| | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 25 | 22 | 45 | 28 | 0 | 1 | 1 | 2 | 0 | 2 | 15 | 9 |
| 2 | 63 | 70 | 36 | 27 | 2 | 2 | 4 | 1 | 2 | 1 | 6 | 4 |
| 3 | 99 | 76 | 36 | 20 | 2 | 0 | 4 | 12 | 1 | 2 | 4 | 3 |
| 4 | 139 | 120 | 15 | 29 | 0 | 1 | 30 | 23 | 0 | 1 | 1 | 1 |
| 5 | 26 | 34 | 30 | 22 | | | 57 | 79 | 15 | 38 | 3 | 2 |
| 6 | 33 | 54 | 34 | 14 | | | 331 | 307 | 2 | 5 | 1 | 1 |
| 7 | 19 | 14 | 58 | 48 | | | 52 | 71 | 0 | 3 | 1 | 1 |
| 8 | 17 | 9 | 84 | 51 | | | 8 | 6 | 4 | 4 | 7 | 4 |
| 9 | 29 | 18 | 20 | 25 | | | 1 | 1 | 4 | 3 | 2 | 1 |
| 10 | 42 | 36 | 68 | 53 | | | 3 | 0 | 2 | 2 | 4 | 0 |
| 11 | 14 | 17 | 423 | 245 | | | | | 4 | 7 | 7 | 6 |
| 12 | 17 | 21 | 138 | 118 | | | | | 4 | 6 | 17 | 12 |
| 13 | 9 | 19 | 280 | 261 | | | | | 3 | 1 | 14 | 20 |
| 14 | 18 | 10 | 227 | 165 | | | | | 4 | 3 | 37 | 26 |
| 15 | 16 | 11 | 234 | 215 | | | | | 8 | 8 | 25 | 15 |
| 16 | 25 | 15 | 459 | 405 | | | | | 19 | 7 | 15 | 5 |
| 17 | 36 | 11 | 152 | 154 | | | | | 11 | 7 | 5 | 4 |
| 18 | 25 | 11 | 82 | 63 | | | | | 4 | 4 | 2 | 3 |
| 19 | 16 | 6 | 51 | 29 | | | | | 8 | 11 | 1 | 1 |
| 20 | 19 | 16 | 18 | 16 | | | | | 12 | 10 | 1 | 1 |
| 21 | 46 | 19 | 22 | 12 | | | | | | | 1 | 0 |
| 22 | | | 9 | 7 | | | | | | | 0 | 1 |
| 23 | | | 13 | 11 | | | | | | | | |
| 24 | | | 2 | 2 | | | | | | | | |
| 25 | | | 7 | 2 | | | | | | | | |
| Total | 733 | 609 | 2543 | 2022 | 4 | 4 | 491 | 502 | 107 | 125 | 169 | 120 |
| % Reduction | | 16.9* | | 20.5* | | 0 | | 0 | | 0 | | 29.0* |

Table XVII (cont.)

| Observation Number | *Aphis maidiradicis* Brusly Ck | Brusly Tr | Donaldsonville Ck | Donaldsonville Tr | *Aphis medicaginis* Brusly Ck | Brusly Tr | Donaldsonville Ck | Donaldsonville Tr | *Aphis sambucifoliae* Brusly Ck | Brusly Tr | Donaldsonville Ck | Donaldsonville Tr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 2 | 0 | 2 | 1 | 8 | 2 | 1 | 0 | 1 | 0 | 2 |
| 2 | 6 | 10 | 0 | 3 | 24 | 42 | 0 | 1 | 4 | 0 | 1 | 1 |
| 3 | 6 | 9 | 2 | 0 | 71 | 53 | 0 | 1 | 0 | 1 | 0 | 2 |
| 4 | 3 | 0 | 1 | 2 | 97 | 95 | 2 | 1 | | | 4 | 4 |
| 5 | 0 | 2 | 2 | 2 | 16 | 21 | 2 | 0 | | | 2 | 2 |
| 6 | 1 | 0 | 0 | 1 | 5 | 10 | 2 | 0 | | | 0 | 2 |
| 7 | 1 | 1 | 3 | 5 | 4 | 0 | 1 | 1 | | | 1 | 0 |
| 8 | 0 | 2 | 14 | 12 | 2 | 3 | 1 | 0 | | | | |
| 9 | 0 | 1 | 38 | 30 | 0 | 1 | 63 | 41 | | | | |
| 10 | 0 | 3 | 13 | 14 | 1 | 0 | 37 | 27 | | | | |
| 11 | 1 | 0 | 47 | 32 | | | 126 | 106 | | | | |
| 12 | 1 | 0 | 63 | 35 | | | 87 | 53 | | | | |
| 13 | 1 | 0 | 31 | 14 | | | 60 | 40 | | | | |
| 14 | | | 11 | 11 | | | 32 | 29 | | | | |
| 15 | | | 11 | 2 | | | 16 | 23 | | | | |
| 16 | | | 3 | 1 | | | 3 | 3 | | | | |
| 17 | | | 3 | 3 | | | 1 | 0 | | | | |
| 18 | | | 1 | 0 | | | 2 | 1 | | | | |
| 19 | | | | | | | 0 | 2 | | | | |
| 20 | | | | | | | 2 | 0 | | | | |
| 21 | | | | | | | 0 | 1 | | | | |
| Total | 24 | 30 | 243 | 169 | 221 | 233 | 439 | 331 | 4 | 2 | 8 | 13 |
| % Reduction | | 0 | | 30.4* | | 0 | | 24.6* | | 50.0 ns | | 0 |

Table XVII (cont.)

| Observation | *Hysteroneura setariae* | | | | *Myzus persicae* | | | | *Rhopalosiphum fitchii* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | |
| Number | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 1 | 0 | 12 | 3 | 0 | 2 | 2 | 0 | 1 | 0 | 1 | 3 |
| 2 | | | 1 | 3 | 0 | 2 | 1 | 0 | | | 11 | 1 |
| 3 | | | 0 | 7 | | | 2 | 0 | | | 2 | 6 |
| 4 | | | 1 | 2 | | | 1 | 0 | | | 1 | 0 |
| 5 | | | 4 | 10 | | | 1 | 3 | | | 1 | 3 |
| 6 | | | 9 | 5 | | | 2 | 0 | | | 5 | 0 |
| 7 | | | 1 | 1 | | | 67 | 43 | | | 0 | 1 |
| 8 | | | 1 | 0 | | | 29 | 14 | | | | |
| 9 | | | 3 | 0 | | | 13 | 14 | | | | |
| 10 | | | 1 | 0 | | | 12 | 12 | | | | |
| 11 | | | 0 | 1 | | | 3 | 4 | | | | |
| 12 | | | | | | | 1 | 0 | | | | |
| 13 | | | | | | | 1 | 2 | | | | |
| 14 | | | | | | | 0 | 1 | | | | |
| **Total** | 1 | 0 | 33 | 32 | 0 | 4 | 135 | 93 | 1 | 0 | 21 | 14 |
| **% Reduction** | | 0 | | 3.0 ns | | 0 | | 31.1 ns | | | | 33.3 ns |

Table XVII (cont.)

| Observation Number | Rhopalosiphum maidis | | | | Rhopalosiphum pseudobrassicae | | | | Rhopalosiphum splendens | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | |
| | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 2 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 3 | 1 | 11 | 6 |
| 2 | 7 | 4 | 1 | 0 | 0 | 1 | 3 | 0 | 8 | 5 | 10 | 6 |
| 3 | 0 | 3 | 1 | 0 | 2 | 0 | 2 | 2 | 8 | 4 | 10 | 3 |
| 4 | 5 | 0 | 1 | 1 | 12 | 16 | 4 | 2 | 12 | 4 | 7 | 4 |
| 5 | 0 | 2 | 1 | 1 | 3 | 0 | 3 | 6 | 5 | 3 | 3 | 4 |
| 6 | 3 | 1 | 1 | 1 | | | 258 | 115 | 3 | 1 | 15 | 8 |
| 7 | 2 | 0 | 0 | 1 | | | 15 | 24 | 2 | 1 | 20 | 15 |
| 8 | 1 | 0 | 2 | 0 | | | 13 | 11 | 3 | 1 | 17 | 12 |
| 9 | 2 | 1 | 1 | 0 | | | 7 | 10 | 5 | 1 | 13 | 14 |
| 10 | 0 | 2 | 2 | 0 | | | 1 | 5 | 2 | 3 | 20 | 25 |
| 11 | 6 | 5 | 2 | 7 | | | 0 | 1 | 0 | 1 | 15 | 23 |
| 12 | 2 | 1 | 2 | 3 | | | 0 | 1 | 1 | 2 | 17 | 24 |
| 13 | 0 | 1 | 9 | 4 | | | 1 | 2 | 0 | 2 | 25 | 36 |
| 14 | 3 | 1 | 1 | 3 | | | 1 | 0 | 0 | 2 | 22 | 17 |
| 15 | 1 | 0 | 0 | 1 | | | | | 0 | 1 | 8 | 13 |
| 16 | | | 1 | 0 | | | | | 3 | 0 | 4 | 6 |
| 17 | | | 1 | 0 | | | | | 1 | 1 | 2 | 1 |
| 18 | | | 0 | 3 | | | | | 2 | 1 | 3 | 2 |
| 19 | | | 0 | 1 | | | | | | | 1 | 2 |
| 20 | | | 4 | 0 | | | | | | | 2 | 1 |
| 21 | | | | | | | | | | | 0 | 1 |
| 22 | | | | | | | | | | | 1 | 2 |
| 23 | | | | | | | | | | | 1 | 0 |
| Total | 34 | 21 | 31 | 27 | 18 | 17 | 310 | 179 | 58 | 34 | 226 | 225 |
| % Reduction | | 38.2 ns | | 8.7 ns | | 5.6 ns | | 42.3 ns | | 41.4* | | .4 ns |

Table XVII (cont.)

| Observation Number | Schizaphis graminum | | | | Sipha flava | | | | Tetraneura hirsuta | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | | Brusly | | Donaldsonville | |
| | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 1 | 2 | 1 | 0 | 6 | 1 | 1 | 1 | 1 | 1 | 4 | 2 |
| 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 5 |
| 3 | | | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 4 | 3 |
| 4 | | | 1 | 0 | 1 | 1 | 0 | 1 | 4 | 1 | 4 | 10 |
| 5 | | | 0 | 1 | 3 | 0 | 0 | 1 | 3 | 1 | 14 | 5 |
| 6 | | | 1 | 1 | 1 | 0 | 1 | 0 | 4 | 3 | 5 | 3 |
| 7 | | | 2 | 2 | 1 | 1 | 0 | 1 | 3 | 2 | 18 | 5 |
| 8 | | | 2 | 5 | 1 | 3 | 0 | 1 | 7 | 6 | 37 | 18 |
| 9 | | | 0 | 2 | 0 | 1 | 1 | 2 | 13 | 7 | 1 | 2 |
| 10 | | | 6 | 2 | 1 | 0 | 1 | 1 | 10 | 10 | 22 | 9 |
| 11 | | | 2 | 0 | 0 | 3 | 1 | 2 | 7 | 6 | 1 | 0 |
| 12 | | | 10 | 8 | 1 | 1 | 1 | 1 | 4 | 6 | 2 | 2 |
| 13 | | | 2 | 2 | 0 | 1 | 0 | 1 | 8 | 0 | 3 | 1 |
| 14 | | | 9 | 7 | 2 | 1 | 1 | 0 | 8 | 6 | 7 | 2 |
| 15 | | | 0 | 1 | 2 | 1 | 1 | 0 | 11 | 4 | 4 | 1 |
| 16 | | | 1 | 4 | 1 | 0 | 0 | 1 | 14 | 3 | 2 | 1 |
| 17 | | | 1 | 0 | 0 | 1 | 1 | 0 | 8 | 1 | 0 | 1 |
| 18 | | | | | 2 | 3 | 0 | 1 | 5 | 1 | | |
| 19 | | | | | | | 1 | 0 | 5 | 0 | | |
| 20 | | | | | | | | | 24 | 2 | | |
| Total | 2 | 2 | 39 | 36 | 23 | 19 | 10 | 16 | 141 | 61 | 130 | 70 |
| % Reduction | | | | 7.7 ns | | 17.4 ns | | 0 | | 56.7** | | 46.2* |

Table XVII (cont.)

| Observation Number | *Therioaphis maculata* Brusly Ck | Brusly Tr | Donaldsonville Ck | Donaldsonville Tr |
|---|---|---|---|---|
| 1 | 2 | 3 | 0 | 1 |
| 2 | 3 | 5 | 1 | 0 |
| 3 | 12 | 13 | 2 | 0 |
| 4 | 2 | 4 | 1 | 2 |
| 5 | 1 | 2 | 2 | 3 |
| 6 | 3 | 0 | 23 | 19 |
| 7 | 2 | 0 | 35 | 27 |
| 8 | 3 | 1 | 14 | 9 |
| 9 | 1 | 2 | 4 | 4 |
| 10 | 1 | 0 | 3 | 1 |
| 11 | | | 4 | 2 |
| 12 | | | 1 | 0 |
| Total | 30 | 30 | 90 | 68 |
| % Reduction | | 0 | | 24.4* |

Table XVIII. Numbers of aphids caught on sugarcane plants during periods of demeton applications in demeton-treated and untreated plots of field experiments at Brusly and Donaldsonville, Louisiana, 1962-63.

| Brusly | | | Donaldsonville | | | | |
|---|---|---|---|---|---|---|---|
| Date of Observation | Winged Adults Ck | Winged Adults Tr | Date of Observation | Winged Adults Ck | Winged Adults Tr | Nymphs Ck | Nymphs Tr |
| 6/8/62 | 6 | 4 | 11/1/62 | 1 | 0 | 1 | 0 |
| 6/15/62 | 2 | 1 | 11/7/62 | 2 | 0 | 4 | 0 |
| 7/6/62 | 3 | 2 | 11/15/62 | 0 | 0 | 5 | 0 |
| 7/20/62 | 3 | 3 | 11/22/62 | 11 | 0 | 6 | 0 |
| 7/21/62 | 3 | 0 | 11/29/62 | 1 | 0 | 4 | 0 |
| 7/27/62 | 4 | 1 | 12/14/62 | 1 | 0 | 1 | 0 |
| 7/28/62 | 2 | 0 | 3/20/63 | 3 | 2 | | |
| 8/4/62 | 1 | 0 | 3/22/63 | 3 | 1 | | |
| 8/11/62 | 6 | 3 | 3/26/63 | 5 | 2 | | |
| 8/17/62 | 3 | 9 | 3/29/63 | 5 | 1 | | |
| 8/25/62 | 1 | 0 | 4/2/63 | 2 | 0 | | |
| 9/2/62 | 0 | 1 | 4/5/63 | 6 | 4 | | |
| 9/9/62 | 1 | 2 | 4/10/63 | 1 | 0 | | |
| 9/11/62 | 1 | 1 | 4/11/63 | 4 | 0 | | |
| 9/16/62 | 1 | 0 | 4/19/63 | 4 | 0 | | |
| 9/22/62 | 0 | 0 | 4/27/63 | 4 | 1 | | |
| | | | 5/3/63 | 5 | 1 | | |
| | | | 5/10/63 | 1 | 0 | | |
| | | | 5/17/63 | 1 | 1 | | |
| | | | 5/24/63 | 1 | 1 | | |
| | | | 6/28/63 | 0 | 1 | | |
| Total | 37 | 27 | | 61 | 14 | 21 | 0 |
| % Reduction | | 27 ns | | | 77** | | 100** |

Table XIX. Numbers of winged adult aphids caught on sugarcane plants at different intervals after demeton applications, in demeton-treated and untreated plots of field experiments at Brusly and Donaldsonville, Louisiana, 1962-63.

| Brusly - 1962 | | | Donaldsonville - 1962-63 | | |
|---|---|---|---|---|---|
| Interval after Insecticide Application | Ck | Tr | Interval after Insecticide Application | Ck | Tr |
| 1 day | 0 | 2 | 2 hours | 16 | 0 |
| 2 days | 3 | 1 | 2 days | 0 | 1 |
| 4 days | 6 | 5 | 3 days | 2 | 0 |
| 8 days | 3 | 2 | 4 days | 6 | 2 |
| 9 days | 6 | 5 | 5 days | 13 | 3 |
| 10 days | 3 | 7 | 6 days | 16 | 6 |
| 11 days | 3 | 3 | 7 days | 8 | 2 |
| 12 days | 3 | 0 | | | |
| 17 days | 1 | 0 | | | |
| 18 days | 4 | 1 | | | |
| 19 days | 3 | 1 | | | |
| 24 days | 1 | 0 | | | |
| 26 days | 1 | 0 | | | |
| Total | 37 | 27 | Total | 61 | 14 |

Table XX. Numbers of different species of winged adult aphids caught on sugarcane plants during the period of demeton applications in demeton-treated and untreated plots of field experiments at Brusly and Donaldsonville, Louisiana, 1962-63.

| Aphid Species | Brusly - 1962 Ck | Brusly - 1962 Tr | Donaldsonville - 1962-63 Ck | Donaldsonville - 1962-63 Tr |
|---|---|---|---|---|
| A. pisum | | | 1 | 0 |
| A. gossypii | | | 1 | 0 |
| A. maidiradicis | | | 7 | 0 |
| A. medicaginis | | | 8 | 2 |
| Aphis sp. | 0 | 1 | | |
| H. setariae | | | 3 | 1 |
| M. persicae | | | 2 | 1 |
| R. fitchii | | | 2 | 2 |
| R. maidis | 18 | 12 | 13 | 3 |
| R. splendens | 1 | 0 | 6 | 2 |
| S. graminum | | | 1 | 0 |
| S. flava | 1 | 0 | | |
| T. hirsuta | 17 | 14 | 2 | 0 |
| Aphids that escaped before identification | | | 15 | 3 |
| Total | 37 | 27 | 61 | 14 |

Table XXI. Percentages of 50 randomly selected stalks with visible mosaic symptoms on different dates in subplots at the center of the demeton-treated and untreated plots, Brusly, Louisiana, 1962.

| | 5/4 | | 5/11 | | 5/18 | | 5/26 | | 6/1 | | 6/8 | | 6/15 | | 6/23 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subplots | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 4 | 2 | 4 | 0 | 2 | 2 | 6 | 0 | 4 |
| 2 | 0 | 6 | 2 | 4 | 2 | 6 | 0 | 4 | 2 | 8 | 2 | 6 | 0 | 6 | 4 | 4 |
| 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 2 | 0 |
| 4 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 2 | 2 | 2 | 0 |
| 5 | 4 | 0 | 2 | 2 | 4 | 2 | 6 | 2 | 2 | 6 | 4 | 8 | 6 | 4 | 16 | 8 |
| 6 | 0 | 2 | 0 | 2 | 2 | 4 | 0 | 4 | 4 | 4 | 0 | 2 | 2 | 6 | 6 | 4 |
| 7 | 0 | 0 | 2 | 0 | 8 | 2 | 4 | 2 | 8 | 0 | 8 | 0 | 6 | 6 | 8 | 4 |
| 8 | 0 | 2 | 4 | 0 | 6 | 4 | 12 | 0 | 10 | 0 | 8 | 2 | 12 | 4 | 16 | 2 |
| 9 | 4 | 2 | 2 | 2 | 8 | 2 | 2 | 2 | 6 | 2 | 4 | 2 | 4 | 2 | 2 | 2 |
| 10 | 0 | 0 | 4 | 2 | 2 | 2 | 8 | 2 | 14 | 6 | 12 | 4 | 14 | 8 | 18 | 8 |
| Mean | 1.2 | 1.2 | 1.6 | 1.2 | 3.6 | 2.2 | 3.2 | 2.0 | 5.0 | 3.0 | 4.4 | 2.8 | 5.0 | 4.4 | 7.4 | 3.6 |

Table XXI (cont.)

| Subplots | 6/29 Ck | 6/29 Tr | 7/6 Ck | 7/6 Tr | 7/14 Ck | 7/14 Tr | 7/20 Ck | 7/20 Tr | 7/27 Ck | 7/27 Tr | 8/4 Ck | 8/4 Tr | 8/11 Ck | 8/11 Tr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 2 | 4 | 2 | 2 | 2 | 0 |
| 2 | 6 | 4 | 8 | 4 | 10 | 2 | 6 | 4 | 6 | 4 | 10 | 4 | 4 | 2 |
| 3 | 4 | 0 | 6 | 0 | 4 | 0 | 4 | 0 | 6 | 0 | 4 | 0 | 4 | 0 |
| 4 | 2 | 2 | 4 | 2 | 2 | 4 | 4 | 6 | 4 | 4 | 2 | 2 | 2 | 2 |
| 5 | 8 | 2 | 8 | 4 | 2 | 0 | 10 | 6 | 8 | 4 | 8 | 0 | 6 | 6 |
| 6 | 2 | 4 | 4 | 4 | 2 | 2 | 2 | 4 | 0 | 2 | 2 | 0 | 0 | 0 |
| 7 | 10 | 2 | 4 | 4 | 6 | 4 | 2 | 4 | 4 | 2 | 6 | 0 | 4 | 0 |
| 8 | 12 | 0 | 12 | 0 | 6 | 2 | 8 | 0 | 10 | 0 | 8 | 6 | 6 | 0 |
| 9 | 4 | 0 | 6 | 0 | 4 | 2 | 2 | 0 | 2 | 4 | 0 | 2 | 2 | 2 |
| 10 | 14 | 14 | 12 | 8 | 12 | 10 | 10 | 8 | 10 | 8 | 10 | 10 | 10 | 10 |
| Mean | 6.2 | 3.0 | 6.6 | 3.0 | 5.0 | 2.8 | 5.0 | 3.4 | 5.2 | 3.2 | 5.2 | 2.6 | 4.0 | 2.2 |

Table XXI (cont.)

| Subplots | 8/17 Ck | 8/17 Tr | 8/24 Ck | 8/24 Tr | 9/2 Ck | 9/2 Tr | 9/10 Ck | 9/10 Tr | 9/15 Ck | 9/15 Tr | 9/23 Ck | 9/23 Tr | 9/29 Ck | 9/29 Tr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 2 | 4 | 0 | 6 | 4 | 4 | 4 | 6 | 0 | 6 | 0 |
| 2 | 2 | 2 | 4 | 0 | 4 | 4 | 6 | 0 | 14 | 0 | 14 | 0 | 8 | 2 |
| 3 | 6 | 0 | 2 | 0 | 8 | 0 | 6 | 0 | 10 | 0 | 4 | 0 | 10 | 2 |
| 4 | 4 | 4 | 2 | 2 | 8 | 4 | 4 | 6 | 6 | 8 | 4 | 6 | 8 | 4 |
| 5 | 12 | 2 | 10 | 4 | 8 | 4 | 8 | 4 | 10 | 6 | 14 | 4 | 10 | 10 |
| 6 | 4 | 2 | 4 | 0 | 0 | 0 | 4 | 2 | 4 | 6 | 4 | 0 | 8 | 6 |
| 7 | 8 | 0 | 10 | 4 | 6 | 2 | 8 | 4 | 8 | 4 | 12 | 2 | 12 | 6 |
| 8 | 6 | 4 | 10 | 2 | 14 | 2 | 16 | 0 | 12 | 4 | 18 | 2 | 16 | 2 |
| 9 | 0 | 2 | 0 | 4 | 2 | 4 | 4 | 2 | 8 | 4 | 2 | 4 | 4 | 4 |
| 10 | 6 | 6 | 12 | 6 | 14 | 6 | 12 | 8 | 12 | 12 | 20 | 10 | 24 | 8 |
| Mean | 5.0 | 2.4 | 5.6 | 2.4 | 6.8 | 2.6 | 7.4 | 3.0 | 8.8 | 4.8 | 9.8 | 2.8 | 10.6 | 4.4 |

F (demeton vs. check) = 51.83**

$F_{.01}$ (1, 21) = 8.02

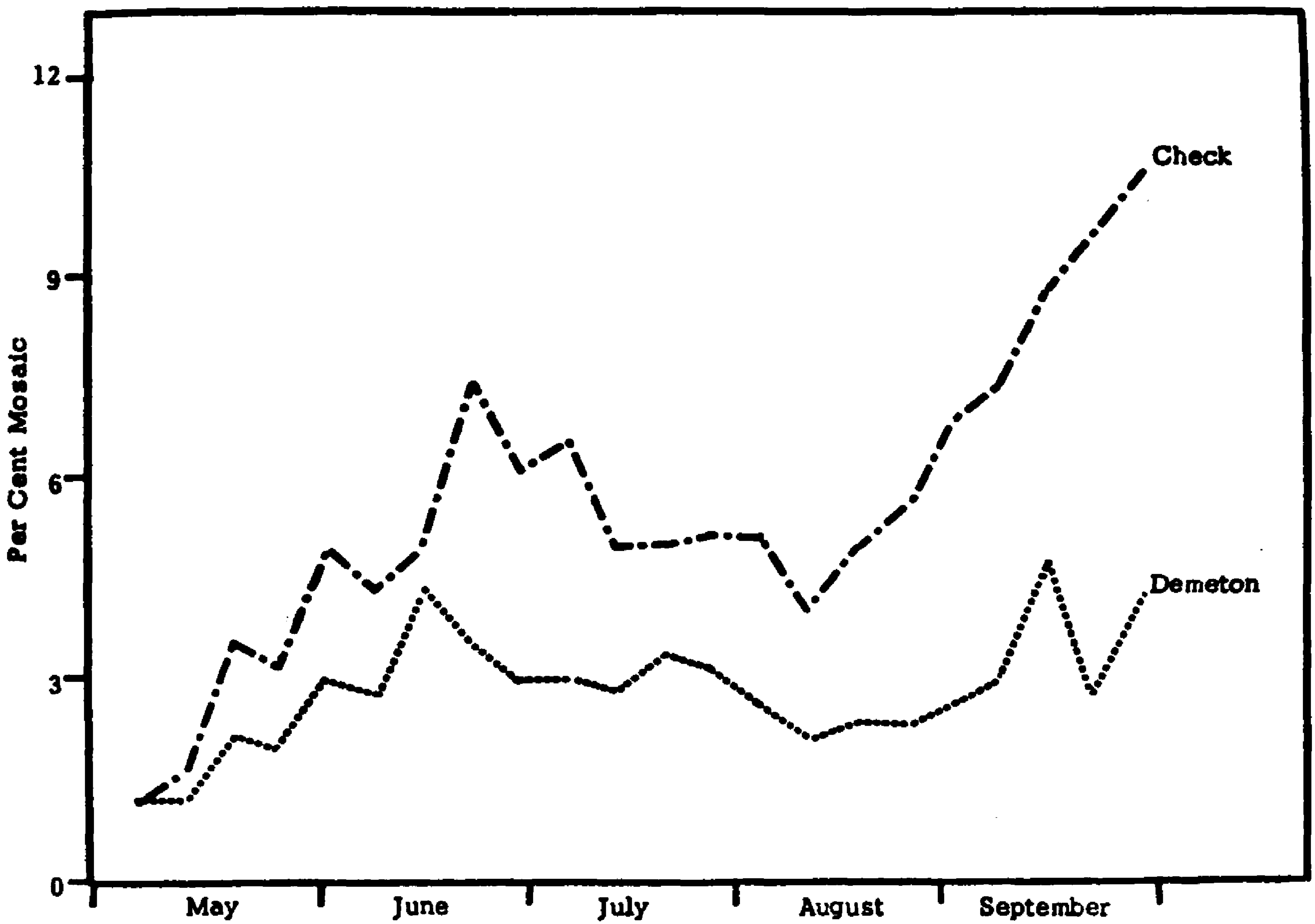


Figure 23. Seasonal incidence of mosaic symptoms in a demeton-treated plot and in surrounding untreated plots of sugarcane, Brusly, Louisiana, 1962.

Table XXII. Percentages of 50 randomly selected stalks with visible mosaic symptoms on different dates in subplots at the center of the demeton-treated and untreated plots, Donaldsonville, Louisiana, 1963.

| | 4/11 | | 4/19 | | 4/27 | | 5/3 | | 5/10 | | 5/17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subplots | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 6 | 6 | 14 | 6 | 14 | 8 | 14 | 6 | 18 | 10 | 16 | 8 |
| 2 | 16 | 8 | 18 | 4 | 22 | 4 | 16 | 8 | 18 | 12 | 20 | 14 |
| 3 | 10 | 4 | 12 | 6 | 22 | 6 | 14 | 2 | 22 | 4 | 14 | 6 |
| 4 | 10 | 4 | 6 | 8 | 14 | 6 | 6 | 10 | 6 | 10 | 12 | 10 |
| 5 | 10 | 2 | 8 | 2 | 6 | 0 | 10 | 2 | 8 | 2 | 10 | 4 |
| Mean | 10.4 | 4.8 | 11.6 | 5.2 | 15.6 | 4.8 | 12.0 | 5.6 | 14.4 | 7.6 | 14.4 | 8.4 |

| | 5/24 | | 5/31 | | 6/6 | | 6/13 | | 6/21 | | 6/28 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subplots | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 22 | 4 | 18 | 10 | 22 | 6 | 12 | 12 | 22 | 8 | 20 | 8 |
| 2 | 22 | 10 | 20 | 10 | 24 | 10 | 22 | 16 | 30 | 18 | 28 | 20 |
| 3 | 20 | 12 | 14 | 8 | 18 | 8 | 20 | 4 | 26 | 6 | 20 | 14 |
| 4 | 12 | 8 | 8 | 8 | 10 | 18 | 16 | 24 | 14 | 14 | 12 | 8 |
| 5 | 12 | 6 | 6 | 4 | 10 | 10 | 12 | 4 | 8 | 2 | 12 | 4 |
| Mean | 17.6 | 8.0 | 13.2 | 8.0 | 16.8 | 10.4 | 16.4 | 12.0 | 20.0 | 9.6 | 18.4 | 10.8 |

F (demeton vs. check) = 142.9**

$F_{.01}$ (1, 11) = 9.65

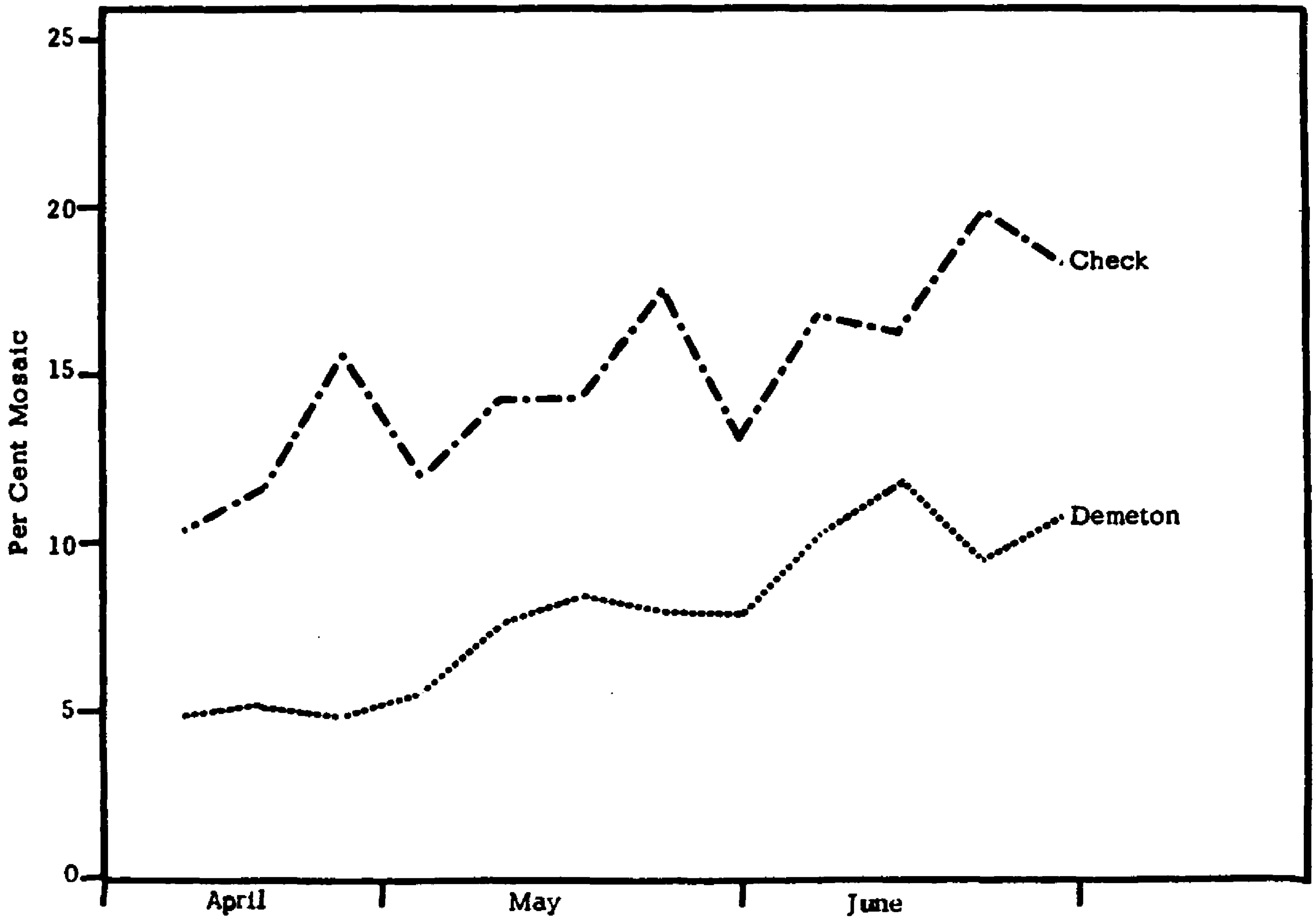


Figure 24. Seasonal incidence of mosaic symptoms in a 10-acre demeton-treated and untreated plot of sugarcane, Donaldsonville, Louisiana, 1963.

Table XXIII. Percentages of 50 randomly selected stalks with visible mosaic symptoms on different dates in rows from the boundary to the center of the demeton-treated and untreated plots, Donaldsonville, Louisiana, 1963.

| Row | 4/11 | | 4/27 | | 5/10 | | 5/24 | | 6/6 | | 6/21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr | Ck | Tr |
| 1 | 0 | 8 | 4 | 6 | 4 | 6 | 2 | 10 | 10 | 12 | 8 | 10 |
| 4 | 4 | 2 | 8 | 8 | 8 | 6 | 16 | 8 | 16 | 12 | 36 | 4 |
| 7 | 6 | 6 | 12 | 8 | 12 | 14 | 16 | 12 | 20 | 10 | 36 | 24 |
| 10 | 8 | 6 | 14 | 14 | 12 | 8 | 18 | 14 | 36 | 16 | 36 | 18 |
| 13 | 10 | 10 | 20 | 14 | 22 | 10 | 24 | 22 | 28 | 14 | 36 | 26 |
| 16 | 12 | 6 | 22 | 4 | 16 | 16 | 18 | 10 | 22 | 12 | 34 | 14 |
| 19 | 4 | 4 | 12 | 10 | 6 | 12 | 10 | 12 | 10 | 18 | 18 | 18 |
| 22 | 12 | 6 | 16 | 6 | 20 | 12 | 20 | 10 | 24 | 12 | 32 | 16 |
| 25 | 10 | 8 | 20 | 8 | 16 | 12 | 16 | 8 | 16 | 16 | 18 | 12 |
| 28 | 8 | 8 | 14 | 12 | 10 | 14 | 12 | 12 | 18 | 14 | 24 | 8 |
| 31 | 8 | 2 | 18 | 4 | 16 | 14 | 22 | 6 | 20 | 8 | 24 | 12 |
| 34 | 10 | 4 | 14 | 4 | 12 | 9 | 10 | 4 | 10 | 14 | 8 | 14 |
| Mean | 7.8 | 5.8 | 14.5 | 8.2 | 12.8 | 10.8 | 15.3 | 10.8 | 19.2 | 13.2 | 25.8 | 14.7 |

F (demeton vs. check) = 14.38*
$F_{.05}$ (1, 5) = 6.61

Table XXIV. Numbers of aphids of different species caught on plants of milk-treated and untreated small plots, Brusly, Louisiana, 1962-63.

| | Check | | Milk-Treated | |
|---|---|---|---|---|
| Aphid Species | Winged Adults | Nymphs | Winged Adults | Nymphs |
| Aphis gossypii | 1 | | | |
| Aphis maidiradicis | 3 | | 4 | |
| Rhopalosiphum maidis | 13 | 10 | 14 | 4 |
| Rhopalosiphum splendens | 1 | | | |
| Tetraneura hirsuta | 3 | | 2 | |
| Total | 21 | 10 | 20 | 4 |

Table XXV. Total numbers of stalks and numbers showing visible mosaic symptoms found in 7 small plots of milk-treated and untreated sugarcane, Brusly, Louisiana, 1962-63.

| Date | Total Numbers of Stalks | | Stalks Showing Mosaic | | Mosaic Per Cent | |
|---|---|---|---|---|---|---|
| | Ck | Tr | Ck | Tr | Ck | Tr |
| 8/25/62 | 366 | 337 | 0 | 0 | 0.0 | 0.0 |
| 9/8/62 | 407 | 393 | 0 | 0 | 0.0 | 0.0 |
| 9/15/62 | 377 | 368 | 2 | 0 | .5 | 0.0 |
| 9/22/62 | 442 | 378 | 2 | 0 | .5 | 0.0 |
| 9/29/62 | 469 | 375 | 2 | 0 | .4 | 0.0 |
| 10/17/62 | 458 | 381 | 3 | 1 | .7 | .3 |
| 10/25/62 | 482 | 392 | 3 | 1 | .6 | .3 |
| 11/7/62 | 513 | 414 | 3 | 1 | .6 | .2 |
| 11/21/62 | 536 | 406 | 5 | 0 | .9 | 0.0 |
| 4/19/63 | 411 | 251 | 29 | 5 | 7.1 | 2.0 |
| 4/27/63 | 467 | 260 | 38 | 8 | 8.1 | 3.1 |
| 5/3/63 | 498 | 302 | 57 | 16 | 11.4 | 5.3 |
| 5/10/63 | 587 | 318 | 74 | 27 | 12.6 | 8.5 |
| 5/17/63 | 683 | 393 | 114 | 36 | 16.7 | 9.2 |
| 5/24/63 | 804 | 437 | 155 | 47 | 19.3 | 10.8 |
| 5/31/63 | 881 | 494 | 170 | 72 | 19.3 | 14.6 |
| 6/6/63 | 933 | 577 | 226 | 94 | 24.2 | 16.3 |
| 6/14/63 | 997 | 586 | 232 | 81 | 23.3** | 13.8 |

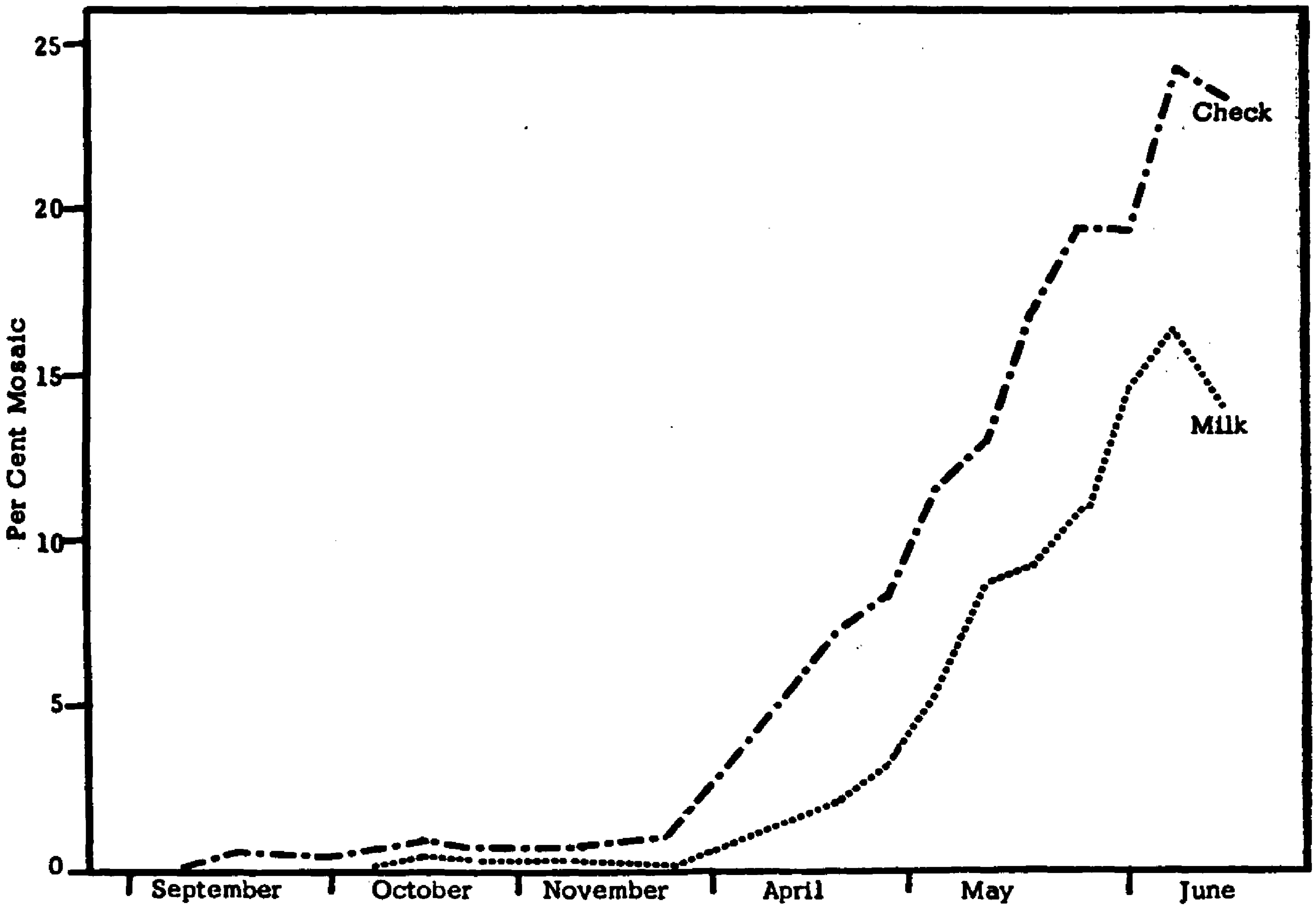


Figure 25. Seasonal incidence of mosaic symptoms in small plots of milk-treated and untreated sugarcane, Brusly, Louisiana, 1962-63.

Table XXVI. Total numbers of stalks and numbers with visible mosaic symptoms in 6 small plots of milk-treated, casein-treated and untreated sugarcane, Donaldsonville, Louisiana, 1963.

| | Total Numbers of Stalks | | | Stalks Showing Mosaic | | | Per Cent Mosaic | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Ck | Mlk | Cs | Ck | Mlk | Cs | Ck | Mlk | Cs |
| 5/31 | 440 | 493 | 559 | 1 | 19 | 17 | 0.0 | 3.9 | 3.0 |
| 6/7 | 552 | 534 | 619 | 14 | 28 | 23 | 2.5 | 5.2 | 3.7 |
| 6/13 | 597 | 583 | 674 | 28 | 31 | 27 | 4.7 | 5.3 | 4.0 |
| 6/22 | 625 | 606 | 681 | 47 | 34 | 46 | 7.5 | 5.6 | 6.8 |
| 6/28 | 651 | 614 | 715 | 59 | 42 | 54 | 9.1 | 6.8 | 7.6 |
| 7/6 | 638 | 551 | 612 | 61 | 43 | 49 | 9.6 | 7.8 | 8.0 |
| 7/11 | 564 | 520 | 564 | 64 | 49 | 57 | 11.4 | 9.4 | 10.1 |
| 7/20 | 533 | 483 | 533 | 67 | 46 | 61 | 12.6 | 9.5 | 11.5 |

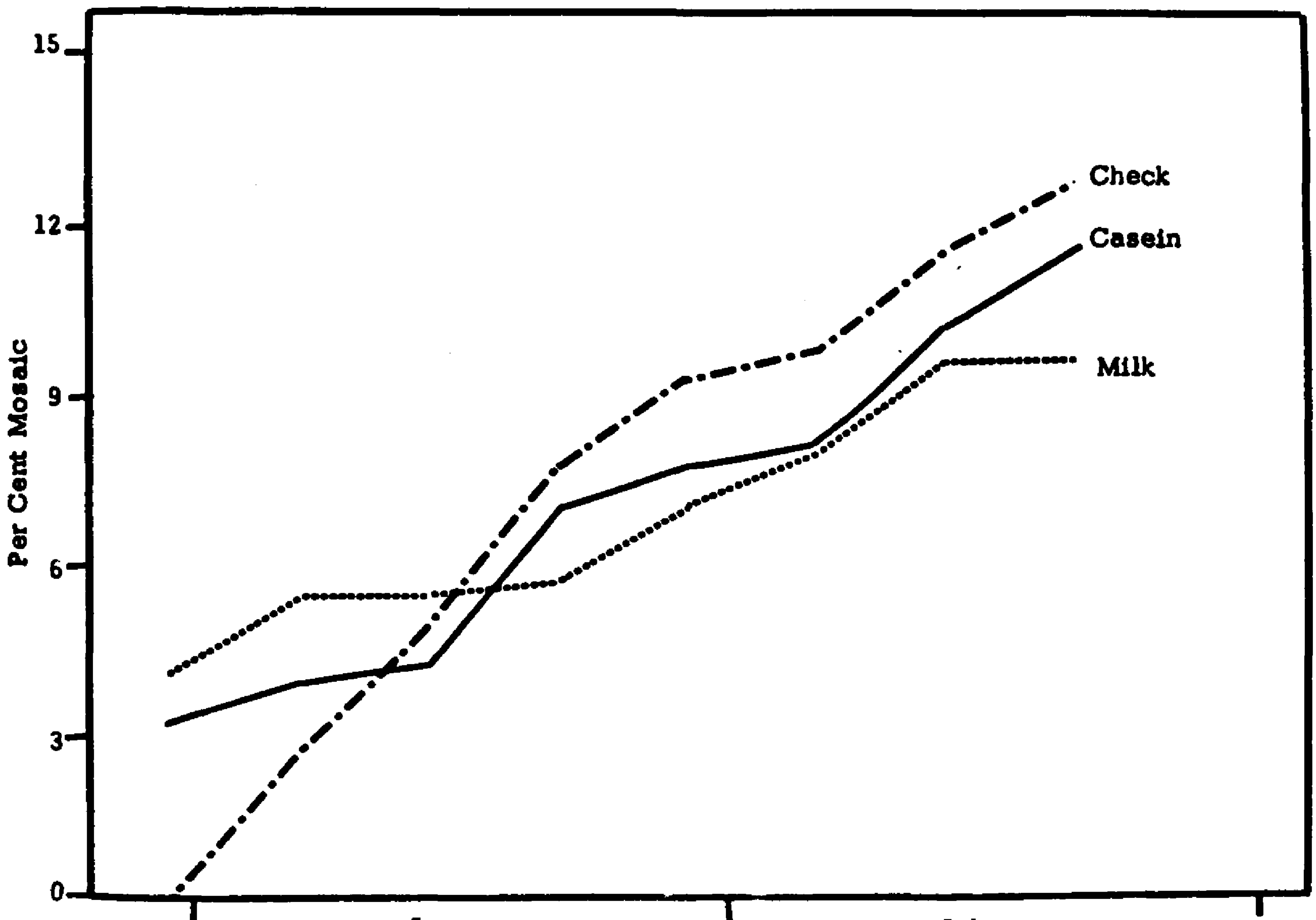


Figure 26. Seasonal incidence of mosaic symptoms in small plots of milk- and casein-treated and untreated sugarcane, Donaldsonville, Louisiana, 1963.

# DISCUSSION

All 7 known aphid vectors of sugarcane mosaic were caught on the sticky traps. However, only *Acyrthosiphon pisum*, *Schizaphis graminum*, *Rhopalosiphum maidis* and *Hysteroneura setariae* were caught in sufficient abundance to be considered important in the spreading of mosaic in this study. Of the other known vectors, only 49 specimens of *Amphorophora sonchi*, 34 of *Dactynotus ambrosiae* and 3 of *Carolinaia cyperi* were trapped during 2 years (Table III).

*Acyrthosiphon pisum* was found most abundantly at Donaldsonville, and mainly during April. *Schizaphis graminum* occurred in abundance at both locations during March and April (Table IV). Both of these species were found only once on plants (Table VIII). *Rhopalosiphum maidis* was the most abundant species caught on plants, but 10 other species were more abundant on sticky traps. This species was not found from January almost to the end of April. It occurred on traps and on sugarcane plants during late spring, summer and fall. This observation conflicts with the findings of Ingram *et al*. (1939) who reported that *Rhopalosiphum maidis* occurs mostly during winter and early spring, and is seldom seen later in the season on sugarcane plants in Louisiana. *Hysteroneura setariae* was found mostly at Donaldsonville, and was caught there only in relatively small numbers compared with the other abundant species caught on sticky traps. However, it was second in abundance among species found on plants. On traps it was caught mostly during the fall, and was relatively scarce during the other seasons, while on plants it was more abundant during July.

Although known vectors of sugarcane mosaic were flying during all periods of mosaic spread, it seems likely that other aphid species not presently known to be vectors may be involved. Known vectors of sugarcane mosaic in corn, such as *Myzus persicae* and *Aphis gossypii*, were flying in relative abundance during major periods of mosaic spread.

The seasonal occurrence of total populations of flying aphids was similar for the 2 years of this study at Brusly and Donaldsonville, respectively. Total flying aphids were relatively abundant during late winter and spring and least abundant during summer (Table IV, Figure 4). In the fall, during which observations were made at Donaldsonville, the total flying aphid population was greater than in either summer, but relatively low compared with the total spring population. At Brusly, in the spring of 1962, flying aphids appeared in abundance about 2 weeks earlier and populations declined sharply 2 weeks later than at Donaldsonville the following year (Table IV, Figure 4). Flying aphids were less abundant during the summer of 1963 than during the summer of 1962.

Since it has been found that 7 species of aphids are capable of transmitting sugarcane mosaic, and it appears reasonable that many others may be found in the future to be capable of transmission, the seasonal abundance of total flying aphids suggests that there probably is more mosaic spread during late winter and spring, and much less during fall and summer. Data obtained in these studies indicate that this is true (Figures 21 and 25).

Since there was severe masking of symptoms during summer followed by reappearance of symptoms in the early fall of 1962, and since no count of mosaic was made during the fall of 1961 at Brusly, only data for the 1962-63 sugarcane growing season at Donaldsonville can be used to compare mosaic spread in different seasons, and to correlate mosaic spread with aphid populations.

The high rate of spread of mosaic symptoms during spring and the relatively low rate of summer spread is indicated in Table IX and Figures 21 and 25. It should be kept in mind that the actual spread of the virus occurred prior to the appearance of symptoms. The assumption of a 4-week latent period of the virus in the plant will be discussed later.

The 4 plantings of sugarcane in 4 different seasons were made in an attempt to learn more about the relative amounts of virus spread which take place at different times of year. The incidence of mosaic symptoms on September 17, 1963 was 31.6%, 19.5%, 9.7% and 1.1%, respectively, for the cane in plantings exposed to airborne aphids from first emergence dates of October 11, 1962, March 29, April 27 and July 23, 1963 until August 22, 1963 (Figure 21). If 31.6% mosaic, which was present in the older plants on September 17, 1963, be considered as 100% of the total disease spread during the growth periods of a normal crop year, then 62% occurred after March, 31% after April, and 3% after July.

More than half of the 12.1% increase in mosaic (31.6%-19.5%, Table IX) which occurred from October to the end of March is believed to have occurred during March, since 817 aphids were caught during the last 3 weeks of March out of a total of 1,285 aphids which were trapped from October 11, 1962 to March 29, 1963. This 12.1% actually represents 38% (100%-62%) of the total disease spread. The numbers of aphids which were trapped from December 28, 1962 to February 28, 1963 are not included here since the aerial parts of plants were dead due to cold weather during this time. Further support of this idea may be seen in the fact that mosaic increased 9.7% (19.5%-9.8%, Table IX) from March 29 to April 27, 1963, during which time 1,200 winged aphids were trapped. Approximately the same species were present during March and April.

The decrease of visible mosaic symptoms at Brusly (Figure 23) during the summer of 1962 is attributed to masking of symptoms rather than to loss of the virus. Table XXIII shows that mosaic incidence was 2.4% and 4.0% at the middle of August, while about 6 weeks later, mosaic was 4.4% and 10.6%, for the treated and the untreated subplots, respectively. During this period, the number of aphids trapped was only about 5% of the total number trapped from March through August. It seems unlikely that such a small number of aphids could have been responsible for more than half of the total virus spread.

Also, Figure 25 indicates that at Brusly there was very little increase of mosaic symptoms from mid-summer through November 21, 1962 in initially disease-free sugarcane planted July 18, 1962 and adjacent to an area where most of the plants had mosaic.

The rate of mosaic spread was approximately equal among plants of different ages (Table IX, Figure 21). Sugarcane normally does not mature under Louisiana conditions so that the whorls of the plants always contain tender leaf tissue. The relatively rapid spread of mosaic during spring apparently did not depend on the age of the plant, but was highly correlated with numbers of flying aphids during this time (Table XIV, Figure 22).

It is known that stylet-borne viruses are easily acquired and easily lost (Sylvester, 1958). Bradley (1959) also found that aphids cease to transmit potato virus Y because the virus is removed from the stylets as they penetrate the leaves. There was some indication that aphids flying from the direction of a field heavily infected with mosaic might have lost their ability to transmit the virus as they flew from plant to plant within the untreated plot in which most of the sugarcane was healthy. At Donaldsonville the incidence of mosaic on the side of the plot close to heavily diseased sugarcane increased from less than 2% to 31%, while on the side close to cane with no mosaic symptoms, incidence increased from less than 2% to 14% (Table X). The distance between these 2 boundaries was 1,000 feet (Figure 3).

There was no ditch at either boundary. The other 2 sides of the plot also were close to heavily diseased cane, but were separated from it by ditches. Here the incidence of mosaic in the rows close to the ditches was less than in the rows at the middle of the cut (Table XXIII).

The exact reasons for these differences are not known. Johnson (1958) stated that aphids alighting after extended flights usually fly only short distances from plant to plant. It seems possible that many such aphids may have lost the virus from their beaks while probing on the abundant grasses in the ditches. The most common grass in these ditches was Johnson grass, Sorghum halepense (L.) Pers., which Edgerton (1959) and other authors believed is not a host of sugarcane mosaic.

Of the 15 most abundant aphid species caught during these studies the elder aphid, Aphis sambucifoliae, was too scarce at Donaldsonville during the 1962-63 season to be included in the correlation analyses. Of the 14 which were included in the correlation analyses, 13 were found on sugarcane plants at one time or another.

It is assumed that many of the aphids collected on plants were probing. The beaks of aphids often were seen in contact with the leaf surfaces, while their antennae were motionless and arched towards the dorsum of the body. Sylvester (1962) believes that this position is characteristic of the probing aphid. When aphids were found feeding on plants, their stylets were inserted deeply into the leaf, and they did not move when disturbed.

When weekly increments of mosaic spread were correlated with the total aphids trapped during equal intervals from 0 to 6 weeks earlier, relatively high correlations (.899 to .923) were found between the occurrence of flying aphids and the appearance of symptoms up to 6 weeks later. There was relatively little correlation (.698 and .408) between aphid numbers and the disease symptoms which appeared 7 and 8 weeks after the occurrence of aphids. Since there was no appreciable difference in correlation coefficients from the 0 to 6 weeks intervals, the time between the occurrence of aphids and the appearance of symptoms cannot be defined exactly. This obscurity is mainly due to the fact that the aphid population was almost constantly high during the spring and then dropped gradually to a constant low during summer. The same thing happened with the spread of mosaic.

The 4-week interval between the occurrence of aphid populations and the appearance of mosaic symptoms was considered reasonable because of 2 lines of reasoning in addition to the correlations mentioned above. First, mosaic symptoms in the experiment of 4 different seasonal plantings appeared 4 weeks after the disease-free seed cane had emerged from the ground in the March 1 and July 11 plantings. Secondly, earlier studies with sugarcane mosaic have suggested an average latent period of slightly more than 3 weeks (Table I).

Twelve aphid species were found by simple correlation to be significantly associated with the spread of mosaic (Table XIV). Unfortunately, most of these species were also highly correlated with each other (Table XVI). This means that most of them occurred in abundance at about the same time. This limited the usefulness of the information obtained by multiple correlation and partial regression procedures.

Myzus persicae, Hysteroneura setariae, Acyrthosiphon pisum, and Schizaphis graminum were found, from the coefficients of simple correlation and partial regression (Table XIV), to be positively and significantly correlated with disease spread. The 3 latter species are known vectors of sugarcane mosaic on sugarcane, and Myzus persicae is a well known vector of more than 50 other viruses and of sugarcane mosaic in corn. The simple correlation coefficients measure the maximum apparent association between each species and the spread of mosaic symptoms. The partial regression coefficients measure the changes in disease incidence which are associated with changes in abundance of each aphid species when all other species are held at their average population levels.

Ten demeton applications during spring and summer of 1962 at Brusly, Louisiana, and 24 weekly applications of demeton during fall and spring of 1962-63 at Donaldsonville, Louisiana resulted in 16.9% and 20.5% reductions in numbers of flying aphids caught on traps (Table XVII), respectively. The reductions in numbers of flying aphids caught on plants were 27% and 77%, at Brusly and Donaldsonville, respectively (Table XVIII).

The occurrence on sticky traps of many aphids of different species which spent relatively little time probing plants, since sugarcane was not their host, might help to explain the fact that demeton applications apparently were more effective in reducing aphids on plants than on traps. However, flying populations of *Sipha flava*, *Hysteroneura setariae* and *Rhopalosiphum maidis*, which are known to colonize on sugarcane, were not significantly reduced on traps by demeton. On the other hand, other species which are not known to colonize on sugarcane were caught on traps in the treated plot in significantly lower numbers than in the untreated plot (Table XVII).

Controlling aphid populations with systemic insecticides alone in order to prevent spreading of sugarcane mosaic in sugarcane to be used for seed was not sufficiently effective in these studies to be considered practical. However, the possible effectiveness of insecticides in combination with periodic roguing of diseased sugarcane and isolation from diseased plants was not studied.

Milk and casein were found to reduce incidence of mosaic symptoms when applied weekly in small plots of sugarcane (Tables XXV and XXVI, Figures 25 and 26). Reduction of mosaic symptoms obtained by skim milk applications was greater than with casein. The way that these substances interfere with aphid transmission was not investigated. It may be possible that the virus was removed from the stylets of the aphids as they penetrated the milk-layer on the leaves or that the milk in some way inactivated the virus on the aphids' stylets as they penetrated the leaves.

Milk applications apparently had no repellent effect on aphids, since approximately the same number of winged aphids were found in both treated and check plots (Table XXIV).

The phytotoxicity associated with treatments with whole milk, and, to a lesser degree with skim milk, might be caused partly by the presence of fats in the milk. However, casein caused some phytotoxicity.

## CONCLUSIONS

1. Fifteen aphid species constituted 92.7% of the 10,084 aphids (representing 69 species) which were caught on sticky traps in sugarcane fields during 1962 and 1963. The 15 most abundant species in order of decreasing abundance were: *Aphis medicaginis*, *Rhopalosiphum pseudobrassicae*, *Acyrthosiphon pisum*, *Rhopalosiphum splendens*, *Aphis gossypii*, *Aphis maidiradicis*, *Myzus persicae*, *Tetraneura hirsuta*, *Schizaphis graminum*, *Therioaphis maculata*, *Rhopalosiphum fitchii*, *Sipha flava*, *Aphis sambucifoliae*, *Rhopalosiphum maidis* and *Hysteroneura setariae*.

2. Sixteen aphid species were collected on sugarcane plants. In their order of decreasing abundance these were: *Rhopalosiphum maidis*, *Hysteroneura setariae*, *Tetraneura hirsuta* (not previously reported in Louisiana), *Aphis maidiradicis*, *Aphis medicaginis*, *Rhopalosiphum splendens*, *Sipha flava*, *Myzus persicae*, *Rhopalosiphum fitchii*, *Aphis gossypii*, *Dactynotus ambrosiae*, *Acyrthosiphon pisum*, *Aphis* sp., *Chaitophorus viminalis*, *Schizaphis graminum*, and *Therioaphis maculata*. The last 5 species were collected only once. All but *Macrosiphum ambrosiae* and *Chaitophorus viminalis* were found in the same fields where sticky traps were maintained. All but *Rhopalosiphum maidis*, *Hysteroneura setariae*, *Sipha flava*, *Dactynotus ambrosiae*, *Acyrthosiphon pisum*, and *Schizaphis graminum*

are here reported for the first time on sugarcane in Louisiana. Only Hysteroneura setariae and Rhopalosiphum maidis were found in colonies. Only solitary winged forms of the other species were found on the plants.

3. Winged aphids were caught on sticky traps in greatest abundance during late winter and early spring. Sixty-nine per cent of all aphids trapped at Donaldsonville during a 12 month period were caught during March and April. Flying aphids were much less abundant during fall than during spring, but more abundant in fall than in summer.

4. More aphids were caught on sticky traps which were facing the general direction of prevailing wind.

5. The rate of spread of mosaic virus among relatively healthy plants adjacent to heavily infected sugarcane was approximately twice as great as among plants adjacent to uninfected cane.

6. A survey of 29 fields conducted July 24, 1962 in 7 parishes indicated that there was no significant difference in the amount of mosaic symptoms found between sugarcane plants adjacent to ditchbanks and plants in the center of field cuts.

7. Symptoms of sugarcane mosaic temporarily disappeared from many N.Co. 310 sugarcane plants during the hot dry summer of 1962. However, this apparent masking of symptoms did not occur in C.P. 52-68 sugarcane during the following relatively wet summer.

8. The temporary loss or masking of mosaic symptoms probably is not associated with loss of virus from the plant.

9. It appears that during the 1962-63 crop year approximately 80% of all spread of the mosaic virus occurred during late winter and spring.

10. The rates of mosaic spread during spring and summer were approximately equal among plants of different ages.

11. Mosaic symptoms usually appeared less than 8 weeks after the occurrence of flying aphids in sugarcane fields. Indirect evidence suggests that 4 weeks may be a reasonable approximation of this latent period.

12. A highly significant simple correlation coefficient of .899 was found between periodic increases in mosaic incidence and numbers of all aphids trapped during an equal period of time 4 weeks earlier. A significant simple correlation coefficient of .987 was determined between the last observed mosaic incidence in sugarcane planted in 4 different seasons and the relative numbers of all aphids flying during these 4 different periods of plant growth.

13. Positive and statistically significant simple correlation coefficients were found between periodic increases in mosaic incidence and numbers of *Myzus persicae*, *Hysteroneura setariae*, *Acyrthosiphum pisum*, *Schizaphis graminum*, *Aphis gossypii*, *Aphis maidiradicis*, *Aphis medicaginis*, *Rhopalosiphum pseudobrassicae*, *Rhopalosiphum fitchii*, *Rhopalosiphum maidis*, *Rhopalosiphum splendens* and *Tetraneura hirsuta* trapped during an equal period of time 4 weeks earlier. There are only

slight indications from multiple regression analysis that the first 4 species might be more important in spreading of mosaic virus than the others. However, statistical analyses did not separate vectors from non-vectors.

14. Weekly applications of milk sprays to small field plots of sugarcane reduced the incidence of mosaic symptoms in 2 experiments by 41% and 25%, respectively. Weekly applications of a casein spray caused an 11% reduction of mosaic symptoms in one field experiment.

15. Milk sprays did not influence the numbers of aphids found on treated sugarcane plants.

16. All milk and casein sprays were phytotoxic. However, skim milk was less phytotoxic than undiluted or diluted whole milk, and casein was least phytotoxic of all.

17. A significant 21% reduction in total populations of flying aphids near the center of a 10-acre plot of sugarcane was achieved during 24 weekly applications of demeton to this plot. Insecticide applications affected some species more than others. A significant 57% reduction in numbers of <u>Tetraneura hirsuta</u> caught on traps was the largest reduction obtained for any particular species.

18. Demeton applications apparently were more effective in reducing the numbers of winged aphids found on plants than in reducing the numbers of aphids caught on sticky traps. A significant 77% reduction in total populations of winged aphids was found on plants near

the center of a 10-acre plot of sugarcane during 24 weekly applications of demeton to this plot.

19. Di-Syston apparently did not influence the numbers of flying aphids caught on sticky traps near the center of a 5-acre treated plot.

20. Twelve applications of systemic insecticides in a 5-acre sugarcane plot adjacent to cane with low mosaic incidence reduced mosaic symptoms in the center of this plot by 58%. Twenty-six applications of the same systemic insecticides in a 10-acre plot adjacent to highly diseased cane resulted in a 45% reduction of mosaic in the entire plot.

21. While presently available systemic insecticides may not be adequate by themselves for preventing mosaic spread, it is possible that these insecticides, together with roguing and isolation from virus sources, might provide a better method for maintaining disease-free seed cane than is currently available.

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# BIOGRAPHY

Konstantinos N. Komblas was born on February 10, 1928 at Patras, Greece. He graduated from Third High School, Patras, in 1946, and entered the Agricultural College of Athens in 1947. He obtained the degree of Bachelor of Science from this college in 1954. He served in the Greek Navy from October 1949 to April 1952.

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**EXAMINATION AND THESIS REPORT**

**Candidate:** Konstantinos N. Komblas

**Major Field:** Entomology

**Title of Thesis:** Field studies of aphid vectors of sugar cane mosaic and methods of control.

Approved:

W. Henry Long
Major Professor and Chairman

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